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SURGERY

A Monthly Journal Devoted to the Art and Science of Surgery

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1. Grimson, Marzoni, Reardon and Hendrix: Ann. of Surg., 127: 5, May, 1948.
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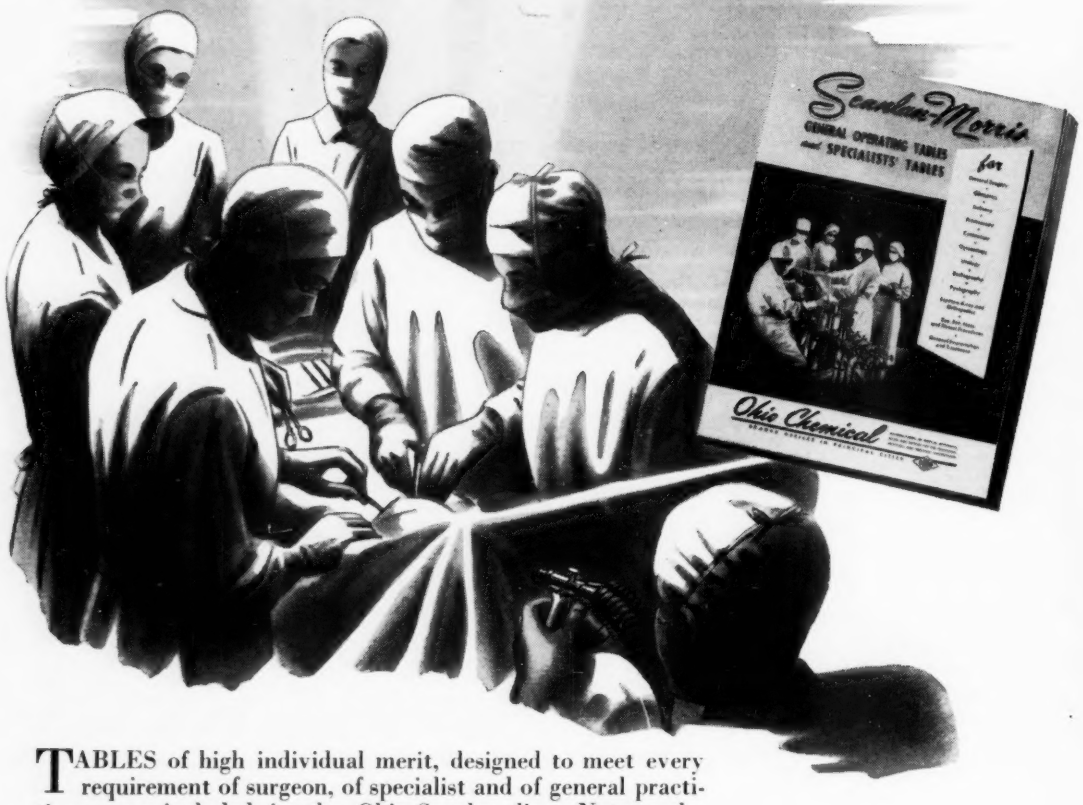

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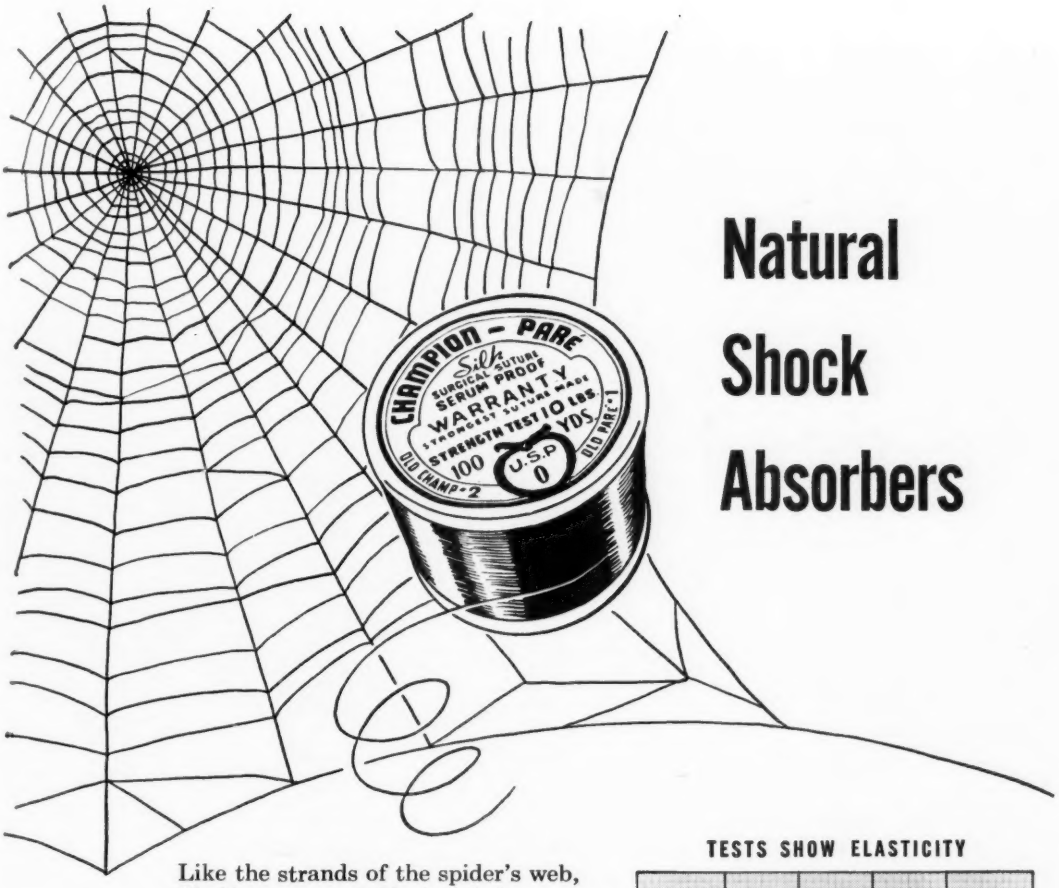

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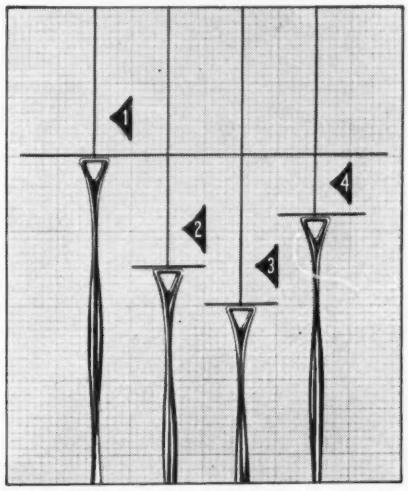

(Fig. 1) An 0 gauge Champion-Paré Serum-Proof Silk Suture prior to stress. **(Fig. 2)** The same, suspending a 5 lb. weight. **(Fig. 3)** The same suture, suspending a 10 lb. weight. **(Fig. 4)** After weights are removed.

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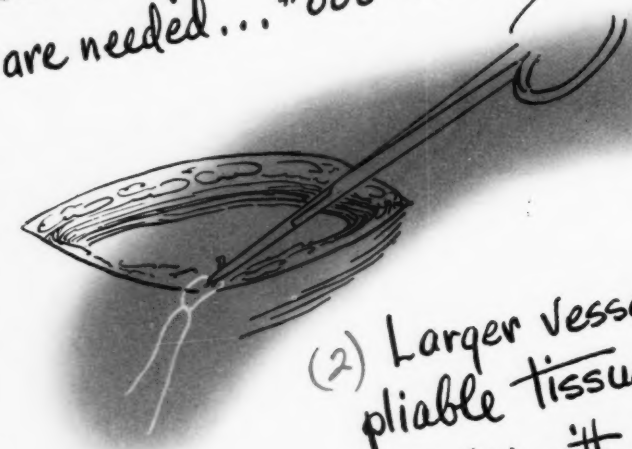
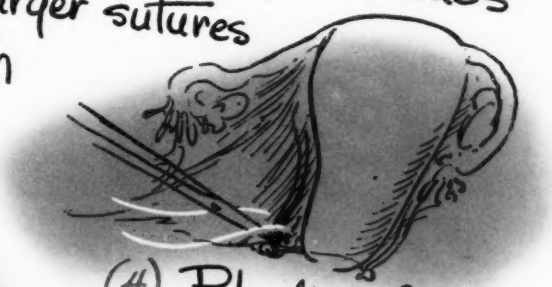


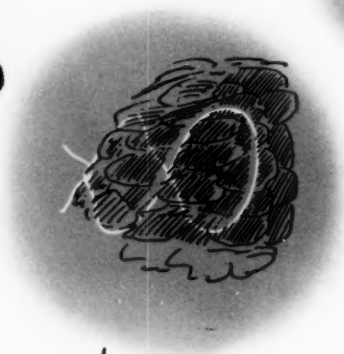
(2) Larger vessels in soft pliable tissues can be ligated with fine sutures – but should be transfixed to neighboring tissues to prevent slipping

SUTUREGRAM

NUMBER THIRTEEN (CONTINUED)

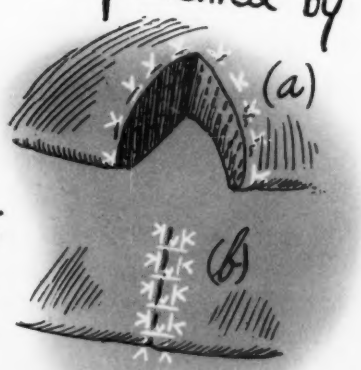
(3) Larger vessels in tough fibrous tissue or imbedded deep in tissues require larger sutures for ligation





(4) Bleeding from vessels which cannot be secured, can be stopped by figure-of-eight suture

(5) Hemorrhage from liver is prevented by placing mattress sutures on both sides of incision (a) then approximating edges with loosely tied sutures (b)



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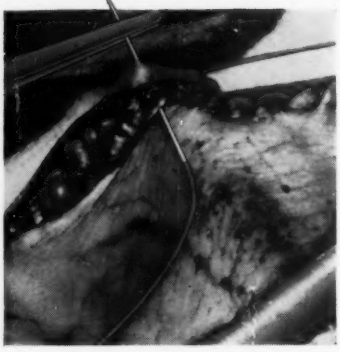

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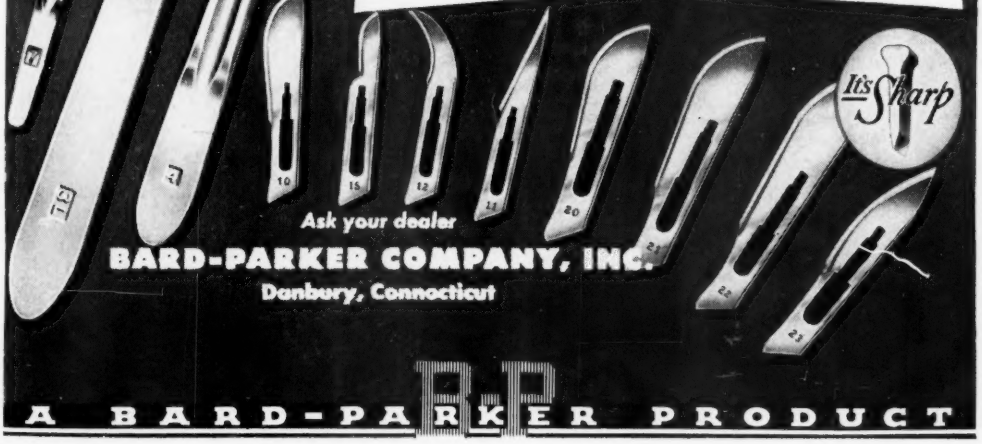

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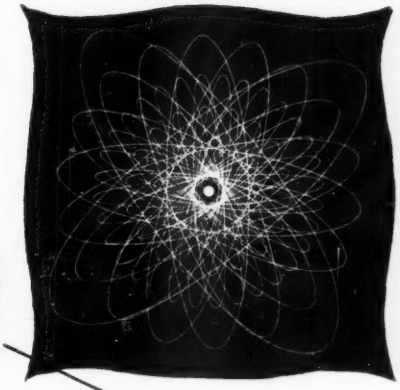

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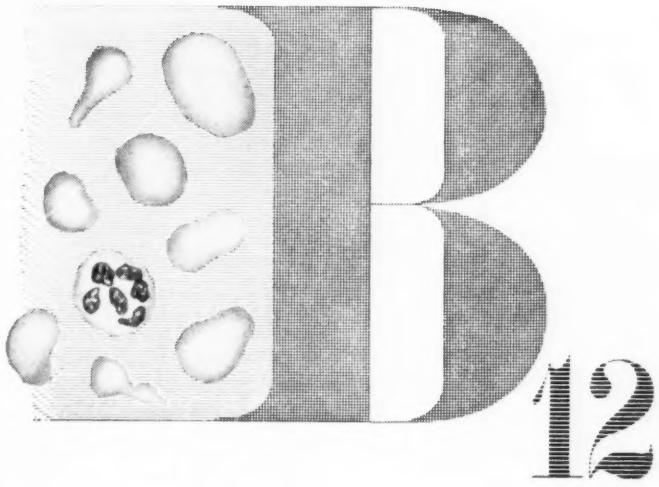

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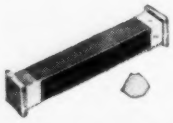

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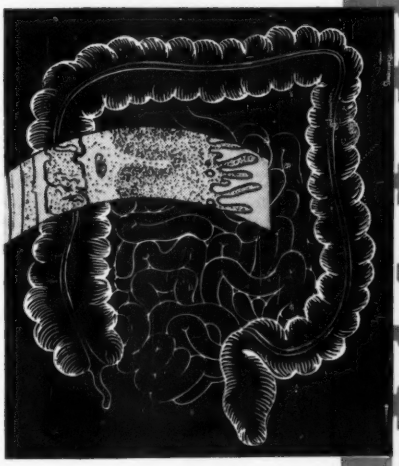

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1. Seneca, H., and Henderson, E.: In press.
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* * *

REFERENCES

1. Postlethwait, R. W., Howard, H. Lee, and Shanher, Paul W.—Comparison of Tissue Reaction to Talc and Modified Starch Glove Powder. Surgery, 1949, 25:22-29.
2. German, W. M.—Lupoid-Sarcoid Reaction Induced by Foreign Body (Silica) Am. J. Clin. Path. 1940, 10:245-250.
3. German, W. M.—Dusting Powder Granulomas Following Surgery. Surg., Gyn. and Obst., 1943, 76:501-507.
4. Seelig, M. G., Verda, D. J., and Kidd, F. H.—The Talcum Powder Problem in Surgery and Its Solution. J.A.M.A. 1943, 123:950.
5. Seelig, M. G.—Talcum as an Operating Room Hazard. South. M. J., 1945, 38: 470-472.
6. Lee, C. M., Jr., and Lehman, E. P.—Experiments with Nonirritating Glove Powder. Surgery, Gynecology and Obstetrics, 84:689-695, April 15, 1947.
7. Lindenmuth, W. M. — Personal communication. To be published.
8. MacQuiddy, E. L., and Tollman, J. P.—Observations on an Absorbable Powder to Replace Talc. Surgery, 1948, 23:786-793.

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RADICAL PANCREATICODUODENECTOMY

REPORT OF TWO CASES OF PROVED SUCCESSFUL IMPLANTATION OF THE PANCREATIC DUCT INTO THE JEJUNUM

JOHN T. REYNOLDS, M.D.,* CHICAGO, ILL., AND HERMAN E. PEARSE, M.D.,† ROCHESTER, N. Y.

THE operation of resection of the head of the pancreas and the duodenum for carcinoma of the pancreas, of the ampulla of Vater, and of the lowermost portion of the common bile duct has assumed an accepted place in surgical therapy.[1, 2] There is agreement, as pointed out by Pearse[3] and others,[4] that the anastomotic reconstruction of the upper gastrointestinal tract after this type of resection should provide for the entrance of bile proximal to the entrance of the gastric contents.

The question of implanting the pancreatic duct has been subject to considerable debate. It has been felt by those who opposed the addition of this step to the operation that the pancreatic juices were not essential to digestion, their premise being that the ferments of the succus entericus would be able to take over the digestive functions of the pancreatic enzymes. They have postulated that in all probability the pancreas would develop atrophy from gradual closure of the duct, and/or from possible low-grade pancreatitis secondary to ascending infection. They have also feared the development of acute pancreatitis. If these presumptions were true, the time needed to implant the pancreas or the duct into the jejunum, and the risk attendant thereto, would be both unnecessary and contraindicated. Their point of view has been considerably strengthened by the fact that the first cases reported (which had apparently done well following the operation) were done without providing any egress for pancreatic juice.

From a theoretical point of view, we have always thought that the duct should be implanted, if possible. Until a few months ago, however, there has been no evidence that would prove that in the human being such an im-

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planted duct was open after implantation or that it would be likely to stay open. We now have 2 specimens which were removed from the bodies of patients 16 and 22 months, respectively, after pancreaticoduodenectomy, in which the pancreatic duct had been implanted into the side of the jejunum. The duct in both specimens was macroscopically patent, the pancreaticojejunal mucosal connection smooth, and the pancreas was grossly and microscopically normal.

CASE REPORTS

CASE 1. (R & E No. 104583 and St. L. No. 83762).—This patient, Mrs. R. C., was 38 years old when she was operated upon at the Copely Hospital in Aurora, Ill., in June, 1948, by one of us (J. T. R.). The symptoms of painless progressive jaundice were of about six weeks' duration at that time. The stool was positive for occult blood. No. x-ray findings of value were made. The tumor which was encountered at the time of operation was about 2 cm. in diameter, originating from the ampulla of Vater. There was no evidence of metastasis seen at the time. The resection was done according to the technique already published by Cole and Reynolds.[5] The pancreatic enzymes were given entrance to the jejunum, using a Vitallium tube as an internal splint. The patient's immediate postoperative course was uneventful and satisfactory. The first six months at home were apparently completely normal. She had normal or slightly constipated stools of normal color. Her strength seemed good and she gained weight. Beginning about six months postoperatively she complained of cramplike pain in the abdomen, pain in the back, and weight loss. At this time no cause could be found for the pain. She returned in October, by which time she weighed only 90 pounds. There was a suggestion of jaundice, and while the abdomen was distended with ascitic fluid, no masses were palpable. On Oct. 12, 1946, at laparotomy about 600 c.c. of bile-stained ascitic fluid were removed. At the time of operation, the liver was found to be normal in size, color, and consistency. At first no carcinoma could be found. The dissection was carried further, and a small mass, unquestionably carcinoma, was found in the base of the mesentery of the small bowel, caudad to the bed of the now absent head of the pancreas. It did not encroach upon any intraperitoneal structure and it measured about 2 by 2 cm. in diameter. From it a biopsy was taken, which was reported later as "metastatic carcinoma." The pancreaticojejunal connection was not seen, although palpation revealed what seemed to be normal pancreas. The gastrojejunostomy was intact and apparently functioned well. An opening inadvertently made into a loop of the jejunum allowed us to palpate the stoma of the common duct from within the jejunal lumen. This stoma seemed to have contracted considerably so that it now admitted only the tip of a Péan forceps. The defect in the duodenum was closed.

The patient died about one week after the operation. Autopsy report* was as follows: Anatomic diagnosis: (1) fibrinopurulent peritonitis; (2) focal areas of abscess formation beneath the dome of the right diaphragm and in the pouch of Douglas; (3) bronchopneumonia, bilaterally; (4) ancient removal of the head of the pancreas, with a gastrojejunostomy, choledochojejunostomy, and anastomosis of the duct of Wirsung to the jejunum; (5) chronic cholecystitis with cholelithiasis with soft granular calculi within the common duct; (6) severe icterus; (7) marked parenchymatous degeneration of the liver and kidneys. In summary, death of the patient was due to a fibrinopurulent peritonitis, following a recent operation. The surgical anastomoses of the pancreatic and common duct were intact and patent. The stoma of the gastrojejunostomy readily admitted two fingers.

Upon comparison of the autopsy findings with those of the operation, it should be noted that although carcinoma was seen with difficulty at operation, it was so small that it was not seen grossly at all in the dissection of the embalmed body. (Microscopic examination

*By Dr. Coye Mason.

Fig. 1.—High-power photomicrograph of mucosa of jejunum. The arrow points to the stoma of the pancreatic duct which had been implanted sixteen months previously. Note the very smooth junction between the jejunal mucosa and that of the mucosa of the pancreatic duct.

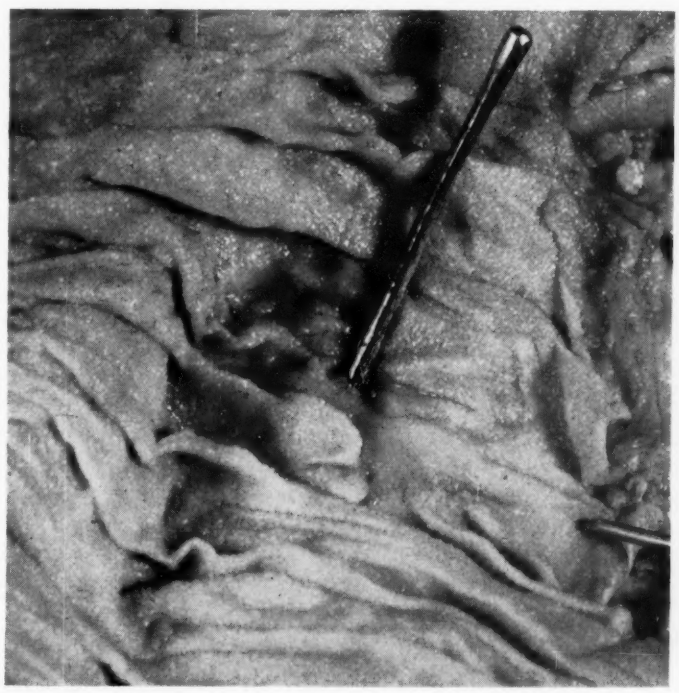


Fig. 2.—Same specimen as Fig. 1, with probe which was introduced from the pancreatic duct in the body of the pancreas and passed into the lumen of the jejunum.

Fig. 3.—The same specimen as Fig. 1, in which the pancreas and jejunum are sectioned through the pancreatic duct to show the smooth mucosal junction of the two structures. Arrow marks point of junction mucosa with the jejunum.

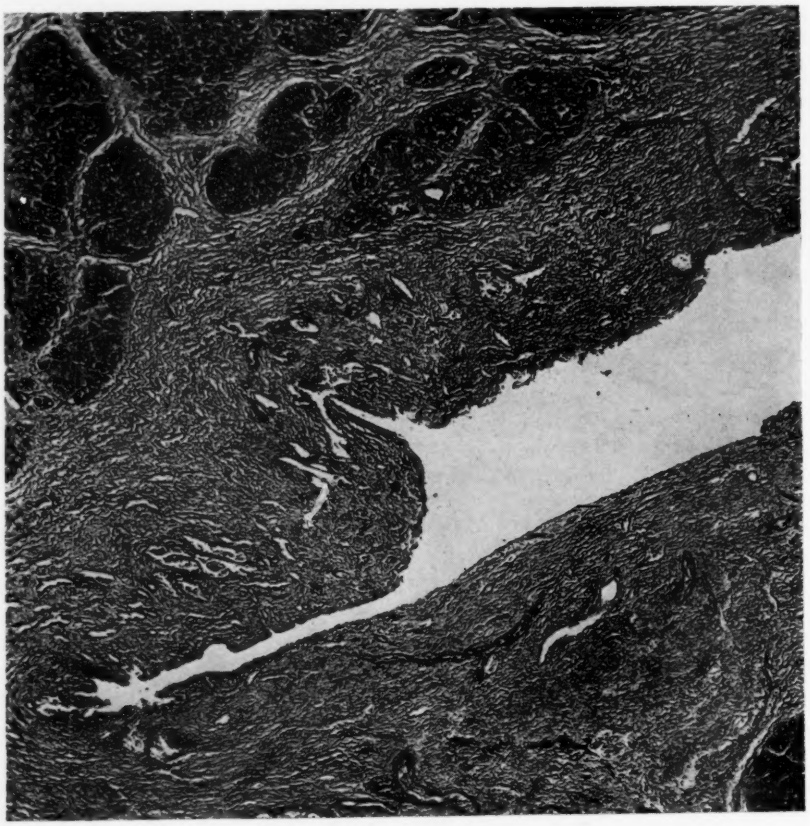


Fig. 4.—Photomicrograph of pancreatic duct a few millimeters within the pancreas. Note the smooth lumen and the lack of inflammation.

of the pancreas later revealed the presence of the carcinoma.) It seems apparent that there was not sufficient carcinoma in the patient's body to explain the cachexia.

The gross specimen studied contained the stomach, the common duct, the pancreas, and the loop of the jejunum into which these structures had been anastomosed. Fixed before autopsy, it was so distorted that a photograph of it merely confuses. We have, therefore, elected to show only the details pertinent to the pancreatic anastomosis. Study of the specimen showed the patency of the pancreatic duct and the smooth healing of the anastomosis between it and the wall of the duodenum (Figs. 1, 2, 3, and 4). There was a considerable amount of pancreatic tissue in the specimen which to gross and microscopic examination was normal; the pancreatic duct apparently had resumed its normal dimensions and to our judgment there was every evidence that the anastomosis between the pancreatic duct and the

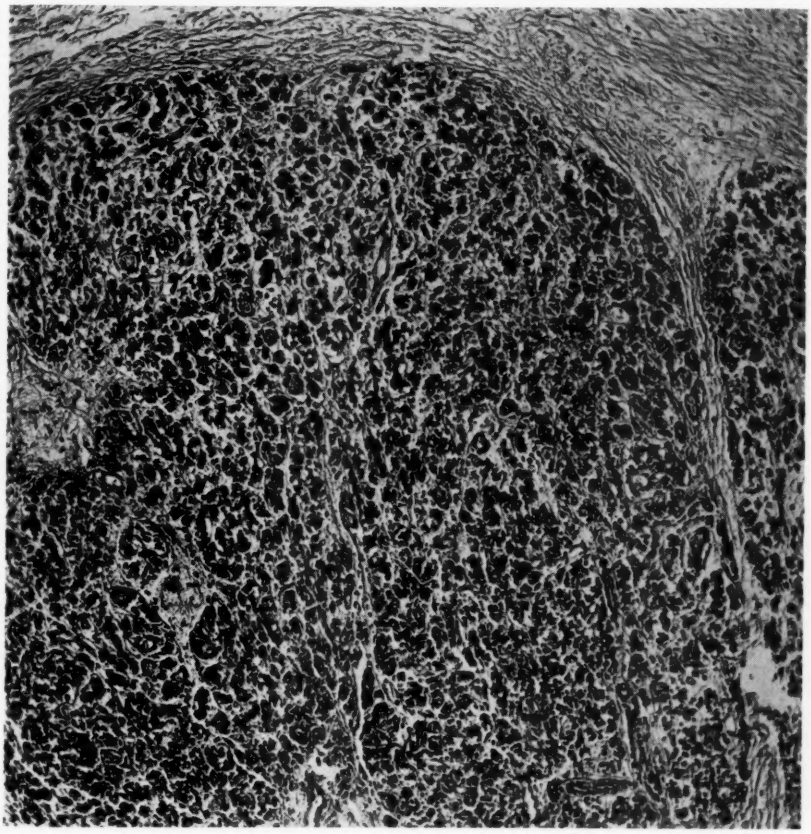


Fig. 5.—Photomicrograph of pancreas showing normal pancreatic tissue.

jejunum had been functioning satisfactorily. There was no pancreatic atrophy and there had been no significant attacks of pancreatitis as judged by the absence of thickening of the pancreatic duct or of fibrosis of the acini of the pancreatic tissue itself (Fig. 5). There was no fatty degeneration of the liver, which showed rather a marked atrophy presumably associated with the generalized advanced cachexia and the superimposed fibropurulent peritonitis.

The site of implantation of the end of the common bile duct into the side of the jejunum showed considerable contraction of the size of the stoma and there was a large soft stone in the common duct.

CASE 2 (No. 226528).—G. M., a 56-year-old woman, was admitted to the Strong Memorial Hospital, Rochester, N. Y., on Nov. 24, 1944, with a complaint of jaundice of five weeks' duration. An attack of anorexia with gaseous indigestion and sour eructations without abdominal pain or bowel disturbance was the first complaint. A few days later she had onset of generalized itching, and noticed jaundice, at which time the urine became dark and the stools light in color. There had been a weight loss of twenty pounds since the onset of the illness.

Physical examination revealed temperature 38° C., pulse 78, respirations 20, blood pressure 110/65. The patient was a deeply jaundiced woman of 56 years, scratching vigorously. She showed signs of recent weight loss. The positive physical findings revealed scleral and cutaneous icterus, excoriations from scratching over the entire body, a slow pulse, but no other cardiovascular abnormalities. An enlarged liver, four fingerbreadths below the costal margin, with a palpable gall bladder was present. There was no enlargement of the spleen, no other masses, and no fluid, distention, or tenderness in the abdomen.

The essential *laboratory findings* were as follows: urine, albumin ±; foam test for bile, +++; stool, gray and semiformed; $HgCl_2$ test negative for bile pigment; guaiac ++++; no ova or parasites seen. Blood: red blood cells 3,600,000; hemoglobin 10.9 gm.; white blood cells 8,200; bleeding time 4½ minutes. Clotting time 6.9 minutes—clot retracts. Prothrombin time 75 and 85 seconds; control 28 seconds.

Blood chemistry: icterus index 72-91; total protein 5.7 Gm. per cent; albumin 3.3 Gm. per cent; globulin 2.4 Gm. per cent; nonprotein nitrogen 29 mg. per cent; phosphorus 3.9 mg. per cent; alkaline phosphatase 24.5; cephalin flocculation, negative. Blood culture was positive for *Staphylococcus aureus* hemolyticus on one occasion, but showed no growth on four other tests.

X-ray examination of the gastrointestinal tract showed indentation of the descending loop of the duodenum by the dilated gall bladder. There was indication of pressure on the medial side of the duodenal loop suspicious of carcinoma of the pancreas. X-ray view of the chest showed elevation of the right diaphragm with sharply outlined costophrenic angle. The lungs were clear.

Course: A diagnosis of carcinoma of the ampulla of Vater was made. She was prepared for operation by the administration of vitamin K, fluids, dextrose, amigen, and blood.

She was operated upon Dec. 1, 1944, by one of us (H. E. P.) under ether anesthesia. A 3 cm. tumor could be palpated in the region of the ampulla of Vater. The duodenum was opened to inspect the tumor, and a typical carcinoma of the ampulla was found. A radical resection was done according to the method previously described.[6] About four inches below this the stomach was anastomosed end-to-side to the jejunum. A drain was placed in the subhepatic space well away from all suture lines and brought out through a right-sided stab wound, after which the wound of exploration was closed. Silk was used throughout the operation.

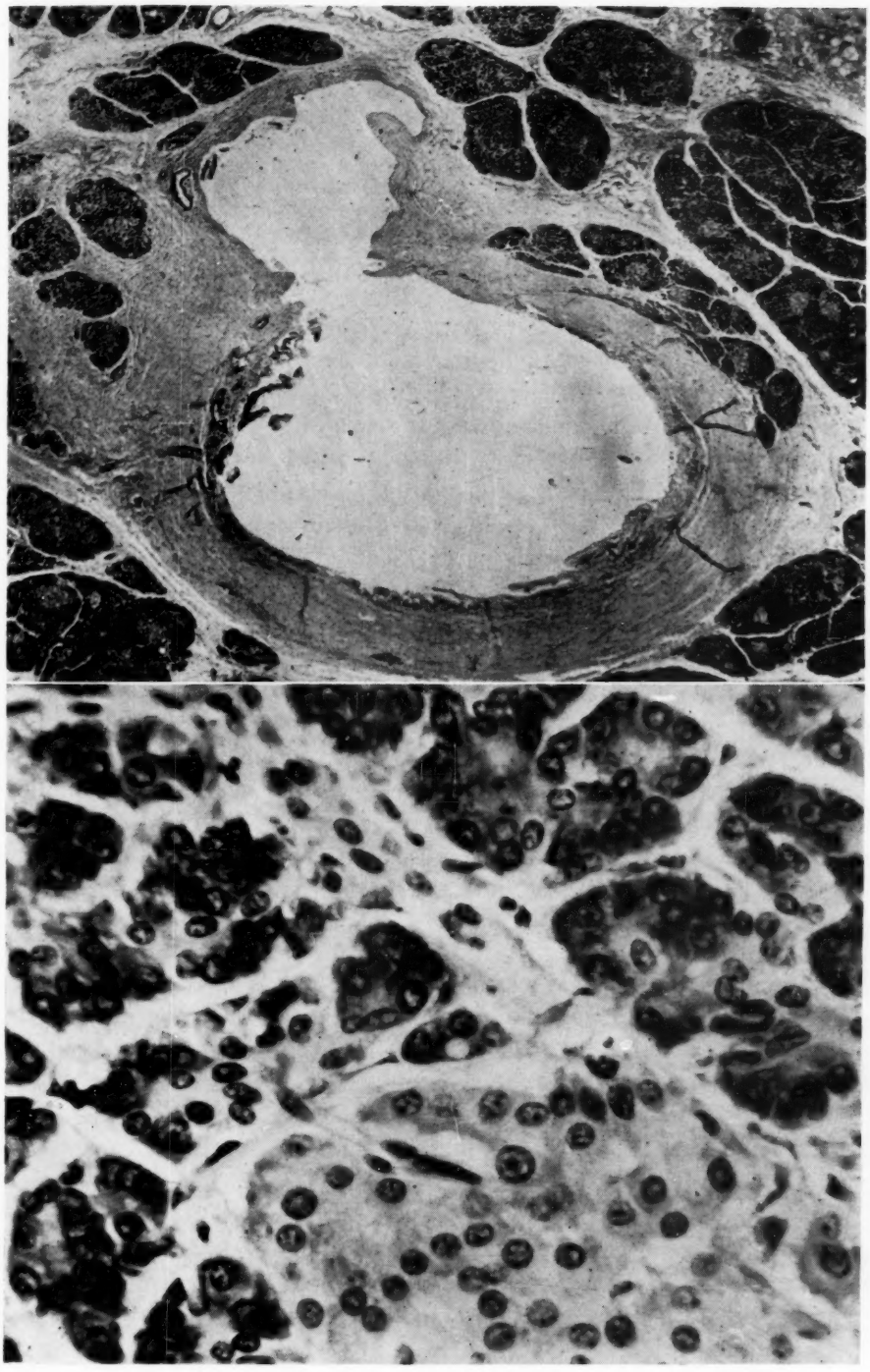
The patient had a febrile preoperative period, with the temperature rising as high as 39.3° C. Fever persisted in the postoperative period for thirteen days.

The pathologic diagnosis was "colloid carcinoma of the duodenum originating in region of ampulla of Vater." The growth was described as a "cauliflower-like, soft villous tumor measuring 3 by 2 by 2 cm." No enlarged lymph nodes were found. It was mentioned that "the tumor elements do not penetrate deeply into the muscle layer of the bowel wall."

The patient was seen for follow-up examination six months later, on June 21, 1945, at which time she had gained twenty-two pounds in weight, was feeling well, and doing her own housework. She had never had diarrhea nor abnormal stools since operation. X-ray examination showed the ureteral catheter still in the pancreatic duct. The gastrojejunostomy functioned well with reflux of only about 1½ inches up the jejunum above the anastomosis.

By Aug. 19, 1946, the patient had lost weight and strength, was anemic, and had upper abdominal pain. Examination revealed an enlarged nodular liver, apparently the site of metastatic carcinoma. X-ray examination of the chest, pelvis, and spine showed no evidence of metastases; she died on Oct. 4, 1946, twenty-two months after operation.

A.



B.

Fig. 6.—*A*, Photomicrograph showing normal pancreatic duct. *B*, High-power photomicrograph showing normal pancreatic acini and islets of Langerhans.

Permission for autopsy was obtained by her physician, and autopsy was done in her home five hours after death. The principal findings were: (1) The liver weighed 7,500 Gm., and was nearly completely replaced by tumor tissue. The intrahepatic bile ducts were not dilated or injected. The choledochojejunostomy was patent. Sections showed nests of tumor cells in the liver parenchyma.

2. The ureteral catheter used in the anastomosis of the pancreatic duct had become impinged against the opposite wall of the jejunum and was fixed in position. The pancreatic duct was slightly dilated about it, but was normal in its distal part. The pancreatic remnant measured 15 by 4 by 1.5 cm. and except for slight increase in interlobar connective tissue appeared grossly normal (Fig. 6, *A* and *B*).

DISCUSSION

A direct connection between the mucosa of the jejunum and that of the pancreatic duct would seem to be the most desirable means of providing a connection for the pancreatic juice. This anastomosis must maintain the patency of the pancreatic duct, and at the same time must not allow leakage of either pancreatic juices or intestinal contents. It seems to be feasible when the pancreatic duct is dilated to such an extent that it can be handled mechanically. The problem arises as to the best method of achieving this without tearing the delicate pancreatic duct. We have found that manipulation of this duct, which is usually quite deeply situated in the abdomen, is difficult, even when the duct is dilated. The danger of traumatizing it beyond repair in the cases reported was a constant possibility.

A Blakemore Vitallium tube, designed for nonsuture anastomosis of blood vessels, was used by one of us (J. T. R.) and a ureteral catheter was used by the other of us (H. E. P.). Poth[7] used a silver cannula both experimentally and in the human being with satisfactory results. The use of an internal splint necessitated relatively little handling of the pancreatic duct, maintained patency of the pancreatic duct lumen, and provided a fairly dependable and yet leakproof connection between the lumen of the pancreatic duct and the lumen of the jejunum.

CONCLUSIONS

The direct implantation of the duct of Wirsung into the side of the jejunum provides a physiologic method of re-establishing complete gastrointestinal connection after this extensive operation. The use of internal splints not only seems to be safe, but seems to be associated with increased technical security. The advantage of a dependable technique for the execution of this delicate anatomic problem is apparent.

Two cases in which the pancreatic duct was implanted into the side of the jejunum are reported in clinical and anatomic detail. Evidence is presented that the duct so implanted achieved a completely satisfactory anatomic connection with the jejunal mucosa; that the pancreas microscopically appears as normal pancreas; and that there was no evidence of pancreatitis either old, recent, or recurrent, nor was there any evidence of pancreatic atrophy. Furthermore, there was clinical evidence that this pancreas supplied the intestinal tract with functioning enzymes, as judged by the gain in weight,

normal stool habit, and consistency. There was no evidence of fatty degeneration of the liver.

REFERENCES

1. Whipple, A. O., Parsons, W. B., and Mullens, C. B.: Treatment of Carcinoma of the Ampulla of Vater, Ann. Surg. **102:** 763, 1935.
Whipple, A. O.: Discussion of paper by Dragstedt, L. R.: Some Physiologic Problems in Surgery of the Pancreas, Ann. Surg. **118:** 589, 1943.
2. Brunschwig, A.: Resection of the Head of the Pancreas and Duodenum for Carcinoma—Pancreaticoduodenectomy, Surg., Gynec. & Obst. **65:** 681, 1937.
Brunschwig, A.: The Surgery of Pancreatic Tumors, St. Louis, 1942, The C. V. Mosby Company.
3. Pearse, H. E.: A Simplified Anastomosis for Resection of the Duodenum and Head of the Pancreas, Surg., Gynec. & Obst. **75:** 333, 1942.
4. Child, C. G.: Pancreaticojejunostomy and Other Problems Associated With the Surgical Management of Carcinoma Involving the Head of the Pancreas, Ann. Surg. **119:** 845, 1944.
Zinninger, M. M.: Radical Resection of the Duodenum and Head of Pancreas for Carcinoma of the Ampulla of Vater; Repair of Pancreatic Fistula Using Vitallium Tube, Cincinnati J. Med. **23:** 174, 1942.
Orr, T. G.: Resection of the Duodenum and the Head of the Pancreas for Carcinoma of the Ampulla, Surg., Gynec. & Obst. **73:** 240, 1941.
Hunt, V. C.: Surgical Management of Carcinoma of the Ampulla of Vater and of the Periampullary Portion of the Duodenum, Ann. Surg. **114:** 570, 1941.
Dennis, C.: A Modified Whipple Operation for Carcinoma of the Head of the Pancreas, SURGERY **12:** 201, 1942.
Dennis, C., and Varco, R. L.: Neoplastic Biliary Obstruction, SURGERY **20:** 72, 1946.
Cattell, R.: Resection of the Pancreas; Discussion of Special Problems, S. Clin. North America **23:** 753, 1944.
Waugh, J. M., and Clagett, O. T.: Resection of the Duodenum and the Head of the Pancreas for Carcinoma; An Analysis of 30 Cases, SURGERY **20:** 224, 1946.
Waugh, J. M.: Resection of Head of Pancreas and Duodenum; Operative Technique, S. Clin. North America **26:** 941, 1946.
5. Cole, W. H., and Reynolds, J. T.: Resection of the Duodenum and Head of the Pancreas for Primary Carcinoma of the Pancreas and the Ampulla of Vater, SURGERY **18:** 133, 1945.
6. Pearse, Herman E.: Should We Standardize the Reconstruction After Pancreaticoduodenectomy? SURGERY **20:** 663, 1946.
7. Poth, E. J.: The Implantation of the Pancreatic Duct Into the Gastrointestinal Tract, SURGERY **15:** 693, 1944.

TOTAL PANCREATECTOMY WITH REPORT OF POSTOPERATIVE PHYSIOLOGIC STUDIES

JACK GREENFIELD, M.D., AND JACK H. SANDERS, M.D., MEMPHIS, TENN.

(From the Surgical Service, Veterans Administration Medical Teaching Group, Kennedy Hospital)

NOT too many years ago it was thought that total extirpation of the pancreas in man was incompatible with life. To date, seventeen cases of total pancreatectomy have been reported in the literature (Table I), of which only seven patients have survived the immediate postoperative period (Table II). The physiologic status and rehabilitation of such surviving patients is of obvious importance in the progress of pancreatic surgery. Some interesting postoperative physiologic studies have been reported in depancreatized human beings, but these have been very few.[1, 2, 3] The purpose of this paper is to present another case of total pancreatectomy for primary carcinoma in which physiologic studies and observations in management were carried out over a period of six months.

CASE REPORT

This 58-year-old colored man was admitted to the Kennedy Veterans Hospital on Jan. 25, 1948, at which time he gave a history of gradual onset of weakness and anorexia of three weeks' duration. These symptoms were associated with occasional nausea, and on one occasion, emesis of clear fluid. About two weeks after the onset he noticed that the urine became darker, stools lighter, and eyes had become yellow. At the same time the skin began to itch and he suffered almost constant periumbilical aching pain which was relieved somewhat by bowel movement. Prior to hospital admission the stools had become distinctly clay-colored. He had had no melena or diarrhea at any time.

Six months previously a local physician had treated him for diabetes because of polydypsia, polyurea, weight loss, weakness, and glycosuria. The diabetes was controlled by insulin for a short time and later by diet alone. Twelve days prior to admission, his physician had again prescribed insulin. Two years previously he had had "heart burn" one to two hours after meals, relieved by soda, of one month's duration. As a younger man he had imbibed whisky heavily, but had given up that habit.

On admission he was a well-developed, fairly well-nourished colored man, weighing 170 pounds. Temperature, pulse, and respirations were normal. The skin showed signs of intense scratching and the sclera had a distinct yellow color. Except for a scaphoid, nontender abdomen with a palpable, smooth, nontender liver edge about 2 cm. below the costal margin, there were no further positive physical findings.

X-ray examination of the chest showed a tortuous aorta. A flat film of the abdomen showed no calculi in the region of the pancreas, or any other pathology. Gastrointestinal barium studies revealed no ulcer or widening of the duodenal loop. The laboratory studies on admission showed: Blood count and hemoglobin were normal; total blood proteins were 7 Gm. per cent with an albumin-globulin ratio of 1.5; fasting blood sugar 250 mg. per cent; blood chlorides 450 mg. per cent; nonprotein nitrogen 24 mg. per cent; prothrombin time 100 per cent without vitamin K administration; serum bilirubin 9.5 mg. per cent and

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TABLE I. CASES OF TOTAL PANCREATECTOMY REPORTED IN THE LITERATURE

AUTHOR	AGE (YR.)	SEX	DIAGNOSIS	SURVIVAL AFTER OPERATION	APPROXIMATE INSULIN DAILY DOSAGE
1. Rockney, 1943	51	M	Carcinoma of pancreas	15 days, died	27 U.
2. Goldner and Clark, 1944 (Case of Brunschwig)			Carcinoma of pancreas	11 days, died	20 U.
3. Goldner and Clark, 1944 (Case of Clark)	45	M	Carcinoma of bile duct	10 days, died	40 U.
4. McClure, 1944 (Case of Fallis)	46	M	Carcinoma of pancreas	Alive 9 mo. after operation	26-34 U.
5. Brunschwig, et al., 1945	53	M	Carcinoma of pancreas	Died 3.5 mo. after operation	40 U.
6. Priestley, 1942	49	F	Islet cell adenoma	Well after 3 yr.	18-25 U.
7. Waugh, 1944	36	F	Islet cell adenoma	Well 8 mo. after operation	32 U.
8. Dixon, 1944	50	M	Carcinoma of pancreas	15 mo. after operation showed recurrent abdominal mass, anemia, and jaundice	40 U.
9. Clagett, 1944	37	F	Chronic pancreatitis with calcification	2.5 mo. after operation, died	38 U.
10. Zinniger, 1945	39	M	Chronic pancreatitis with pancreatic lithiasis	Died 30 hr. after operation	30-50 U.
11. Brunschwig, 1944	67	M	Carcinoma of pancreas	3 days, died	
12. Brunschwig, 1946			Carcinoma of pancreas	14 days, died	
13. Whipple, 1945	26	F	Pancreatic calculi	12 mo., relieved of pain	30-80 U.
14. Whipple, 1945	46	F	Pancreatic calculi	7 days, died	20-40 U.
15. Brunschwig	29	M	Diffuse carcinoma of pancreas	9 days, died	"Less than anticipated"
16. Brunschwig			Sarcoma (origin unknown)	19 days, died	"Diabetes did not appear hard to control"
17. Gaston	70	M	Adenocarcinoma probably arising in papilla of Vater	8 days, died	10-30 Reg.
18. Greenfield and Sanders, 1948	58	M	Adenocarcinoma of pancreas	Living and well 6 mo. after operation, metastases present	40 U. P. Z.

increased to 20.5 mg. per cent on the day before surgery; thymol turbidity was normal; cephalin flocculation 4 plus in forty-eight hours; bleeding and coagulation times normal. The serum alkaline phosphatase rose to 14.9 King-Armstrong units prior to surgery. Repeated stools were clay colored and solid with no ova, parasites, or occult blood. The urine was repeatedly negative for urobilinogen.

During the course of the diagnostic studies, the blood sugar was controlled between 110 and 185 mg. per cent without the use of insulin. In spite of all efforts, the patient lost weight. On the day prior to surgery he weighed 160 pounds. All of the evidence favored a diagnosis of obstructive jaundice due to carcinoma of the head of the pancreas and on Feb. 17, 1948, he was operated upon.

Under endotracheal cyclopropane anesthesia the abdomen was opened through an upper abdominal transverse incision, dividing the rectus muscles. There was no free fluid in the peritoneal cavity. The liver was moderately enlarged, not cirrhotic, and contained no

TABLE II. DATA ON PATIENTS SURVIVING IMMEDIATE POSTOPERATIVE PERIOD

CASE NO.	AUTHOR	DIAGNOSIS SEX, AND AGE	OTHER OPERATIVE PROCEDURES	SURVIVAL AND CAUSE OF DEATH	DIET AND INSULIN	EXTERNAL PANCREATIC SECRETION STUDIES AND PLASMA LIPOIDS	LIVER AND LIVER-FUNCTION STUDIES	REMARKS
1.	Priestly et al.	Hyperinsulinism due to islet-cell adenoma, F., 49 yr.	Partial (distal third) gastrectomy; partial (first and second portions) duodenectomy	Living and well 37 mo. after operation	CHO, 243 Gm.; Prot., 94 Gm.; Fat, 70 Gm., 30 U. insul.	Recovered in feces: 35-70% of ingested fat, 25-55% of ingested nitrogen; recovered in urine and feces: 21-34% of ingested calories; plasma lipoids normal 37 mo. after operation	B.S.P. retention normal 30 mo. after operation	
2.	McClure (Case of Fallis)	Primary carcinoma of pancreas, M., 46 yr.	Total duodenectomy; splenectomy	Living and well 9 mo. after operation	26 U. of P.Z. insul. daily; 8 U. of reg. insul. twice weekly			
3.	Brunschwig et al. Ricketts et al. Ricketts et al. (Case F. W. 328218)	Carcinoma arising in body of pancreas with extension to stomach and left adrenal gland; metastasis to lymph nodes, M., 53 yr.	Total gastrectomy; total duodenectomy; splenectomy; left adrenalectomy; omentumectomy	3½ mo. carcinomatosis and diabetic coma due to insulin withdrawal	CHO, 401 Gm.; prot., 102 Gm.; Fat, 11 Gm.; 30 U. of P.Z. insul.; 10 U. of reg. insul. (frequent hypoglycemic reactions)	Plasma lipoids slowly declined but never abnormal	Liver fatty at autopsy, probably owing to death in diabetic coma	Patient diabetic before operation, requiring more insul. than after operation; preoperative diabetes spontaneous and not due to tumor
4.	Whipple	Chronic pancreatitis; pancreatico-lithiasis, F., 26 yr.	Pylorectomy; total duodenectomy	Alive, with pulmonary T.B., 1 yr. after operation	CHO, 300 Gm.; prot., 70 gm.; Fat, 75 Gm., 30-80 U. insul.			

5.	Waugh et al.	Hyperinsulinism due to islet-cell adenoma, F., 36 yr.	Pylorectomy; partial duodenectomy	Living and well 8 mo. after operation	CHO, 267 Gm.; prot., 125 Gm.; fat, 103 Gm.; 26 U. of reg. insul., 6 U. of P.Z. insul.	Plasma lipoids normal 70 days P.O.		
6.	Dixon	Carcinoma arising in head and involving half of pancreas; remainder atrophic, M., 50 yr.	Partial gastrectomy (distal half); Total duodenectomy; splenectomy	Living with recurrent carcinoma 14 mo. after operation	CHO, 272 Gm.; prot., 107 Gm.; fat, 100 Gm.; 30 U. of reg. insul.; 10 U. of P.Z. insul.	Nitrogen loss in stools, 4-8 Gm. (normal, less than 1.5 Gm.); fat loss in stools, 36-48 Gm. (normal, 6-7 Gm.). 100% increase plasma lipoids 8 mo. after operation	B.S.P. retention normal 8 mo. after operation	Patient diabetic 19 mo. before operation, requiring 20 U. insul. daily
7.	Clagett	Chronic pancreatitis; multiple pancreatic calculi, F., 37 yr.	Partial gastrectomy; partial duodenectomy; splenectomy	2½ mo. insulin reaction	CHO, 250 Gm.; prot., 75 Gm.; fat, 101 Gm.; 30 U. reg. insul.	Plasma lipoids normal 1 mo. after operation	B.S.P. retention normal 1 mo. after operation	Prolonged drainage of common bile duct did not relieve symptoms before pancreatectomy
8.	Greenfield and Sanders	Adenocarcinoma of the pancreas with associated chronic pancreatitis, M., 58 yr.	Splenectomy; total duodenectomy; pylorectomy	Living and well 6 mo. after operation, metastases now evident	CHO, 404 Gm.; prot., 182 Gm.; fat, 51 Gm.; 40 U. of P.Z. insul.	68% fat ingested, 18.2% proteins and 457 calories lost in stools (while taking 16 Gm. pancreatin tablets); plasma lipoids normal 6 mo. P.O.	All normal 6 mo. P.O. including B.S.P.	Patient diabetic 6 mo. preoperatively but did not require insul.; maintaining wt. at 155 lb.; does light labor work; has no difficulty caring for diabetes, although he is uneducated

tumor nodules. The gall bladder was thickened and not enlarged. The diameter of the common duct was about twice normal. The entire pancreas was about twice normal in size, stony hard, and a definite difference in firmness could not be palpated in any part of the gland. A frozen section from the head of the pancreas was reported as tumor. An enlarged node behind the common duct, removed at the same time, was reported as containing no tumor cells. Total pancreatectomy was then considered and found to be feasible after exposing the superior mesenteric artery and portal vein beneath the junction of the head and body of the gland. After the duodenum and head of the pancreas were mobilized, the common duct was separated from the hepatic artery and portal vein at its distal end and divided above the tumor. The pyloric end of the stomach was divided between Payr clamps. The jejunum was divided just beyond the ligament of Treitz. The spleen, pancreas, and duodenum were then removed after separating the uncinate process from the superior

Fig. 1.—Surgical specimen showing pancreas and duodenum. Excised spleen is not shown.

mesenteric artery and portal vein (Fig. 1). A retrocolic, antiperistaltic, end-to-end choledochojejunostomy and end-to-side gastrojejunostomy were performed (Fig. 2). Before complete closure of the gastrojejunostomy, the distal end of the previously inserted Einhorn tube was advanced about six inches into the distal jejunal loop. Hemostasis was adequate. Without inserting drains, the peritoneum was closed with a continuous No. 0 chromic catgut suture and the remainder of the abdominal layers with interrupted stainless steel wire sutures.

During the operation, the patient received 1000 c.c. of 5 per cent glucose in saline solution to which were added 25 units of regular insulin. He also received 250 c.c. of human plasma and 2000 c.c. of citrated blood. No anesthesia difficulties were encountered and the patient left the operating room in good condition.

The immediate postoperative course was smooth. The temperature reached only 99° F. for the first three days. After that the patient remained afebrile. For one week he was given 100,000 units of penicillin intramuscularly every three hours. The urinary output was good from the first and hydration was readily maintained with intravenous fluids dur-

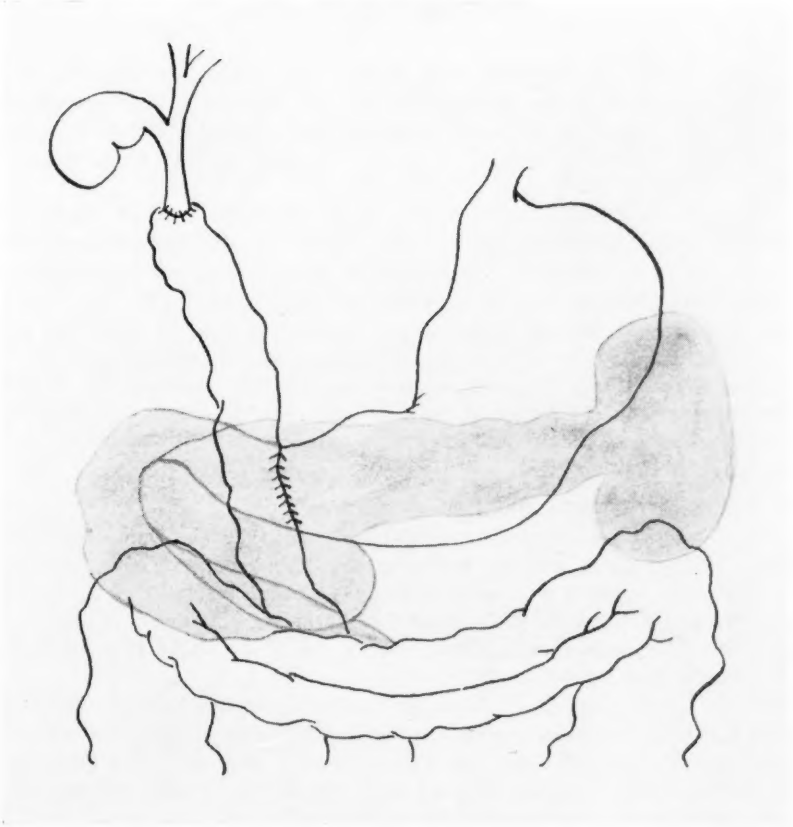

Fig. 2.—Diagram of completed reconstruction. Total pancreaticoduodenectomy; single stage, shaded area removed.

Fig. 3.—Microscopic section through head of pancreas. Note ductile squamous hyperplasia and the marked chronic inflammation around the neoplastic areas.

ing the first two days. On the third postoperative day, partial tube feeding was started through the jejunal section of the double-lumen Einhorn tube. This was coupled with intravenous glucose and protein hydrolysates to which were added vitamins, including "K." On the eighth postoperative day the tube was removed; oral feedings were started, and have been continued to date without any difficulty.

The final pathologic diagnosis was adenocarcinoma of the head of the pancreas with chronic pancreatitis and fibrosis of the body and tail of the pancreas; squamous cell hyperplasia of the ducts of the pancreas; destruction of almost all islands of Langerhans; common duct obstruction; and tumor cells in endothelial-lined spaces (Fig. 3).

During examination in the second month after operation an incisional hernia was noted. This was considerably relieved by an elastic belt. Surgical repair of the hernia was deferred to a later date. However, at five and one-half months after surgery several small nodules appeared in the region of the incision which proved to contain carcinoma on aspiration biopsy. It was decided not to pursue this residual disease surgically, although his general condition was excellent.

Postoperative Management and Physiologic Studies.—

Diabetic state: It was planned to control the patient's diabetes during the immediate postoperative period with a six-hour emergency acidosis regimen. One unit of regular insulin was given for every 2 Gm. of glucose administered intravenously. The urine was tested for sugar and acetone every six hours before each feeding and injection of insulin. Blood sugars were determined twice daily. When the blood sugar rose to above normal values, more insulin was administered.

The greatest fluctuations of the blood glucose levels occurred during the first five days, varying from as much as 400 mg. per cent in the evening to 95 mg. per cent in the morning. Although the highest value of blood glucose was usually reached in the evening, this was not rigidly so. The administration of parenteral glucose and fluids was not the cause of this for they were spaced evenly throughout the twenty-four hour period and the blood glucose samples were taken before the glucose was administered intravenously.

Following this plan, 80 units of regular insulin were given during the second postoperative day to keep the blood glucose at a reasonable level and to prevent the large loss of glucose in the urine, which was taking place. However, on the following day, the blood glucose was 65 mg. per cent although the patient offered no symptoms of hypoglycemia. Following this episode, the plan of diabetic management was immediately altered in that less insulin was prescribed than the blood sugar seemed to indicate, as long as the urine was free of acetone (Chart 1).

After the seventh postoperative day, when the patient was taking all feedings orally, 40 units of regular insulin were found to be sufficient. This was given in divided doses every six hours. The blood glucose level fluctuated considerably, but did not reach the levels attained during the first few postoperative days.

On the twenty-third postoperative day it was noticed that a considerable amount of glucose was present in the morning urines. On the twenty-fifth day, protamine zinc insulin was started. An additional 10 units of regular insulin were given in the same syringe with the 40 units of protamine zinc insulin, to overcome the excessive urinary glucose. That this dosage was excessive was evident on the twenty-eighth postoperative day (Chart 1) when, just prior to his noon meal, the patient complained of hunger and nervousness and displayed mild tremors. These symptoms disappeared dramatically with a glass of orange juice. A blood sugar sample taken at that time was reported as 58 mg. per cent. This episode was significant in the patient's diabetic education. The 10 units of regular insulin were discontinued. The daily morning doses of 40 units of protamine zinc insulin have been continued to date.

A period of mild acidosis occurred on the eighty-sixth and eighty-seventh postoperative days, when the patient developed a moderate cellulitis of the cheek subsequent to the extraction of eight teeth, at one sitting, for chronic pyorrhea (Chart 1). The soft tissues over the right mandible became swollen and tender, but he remained afebrile. As a result

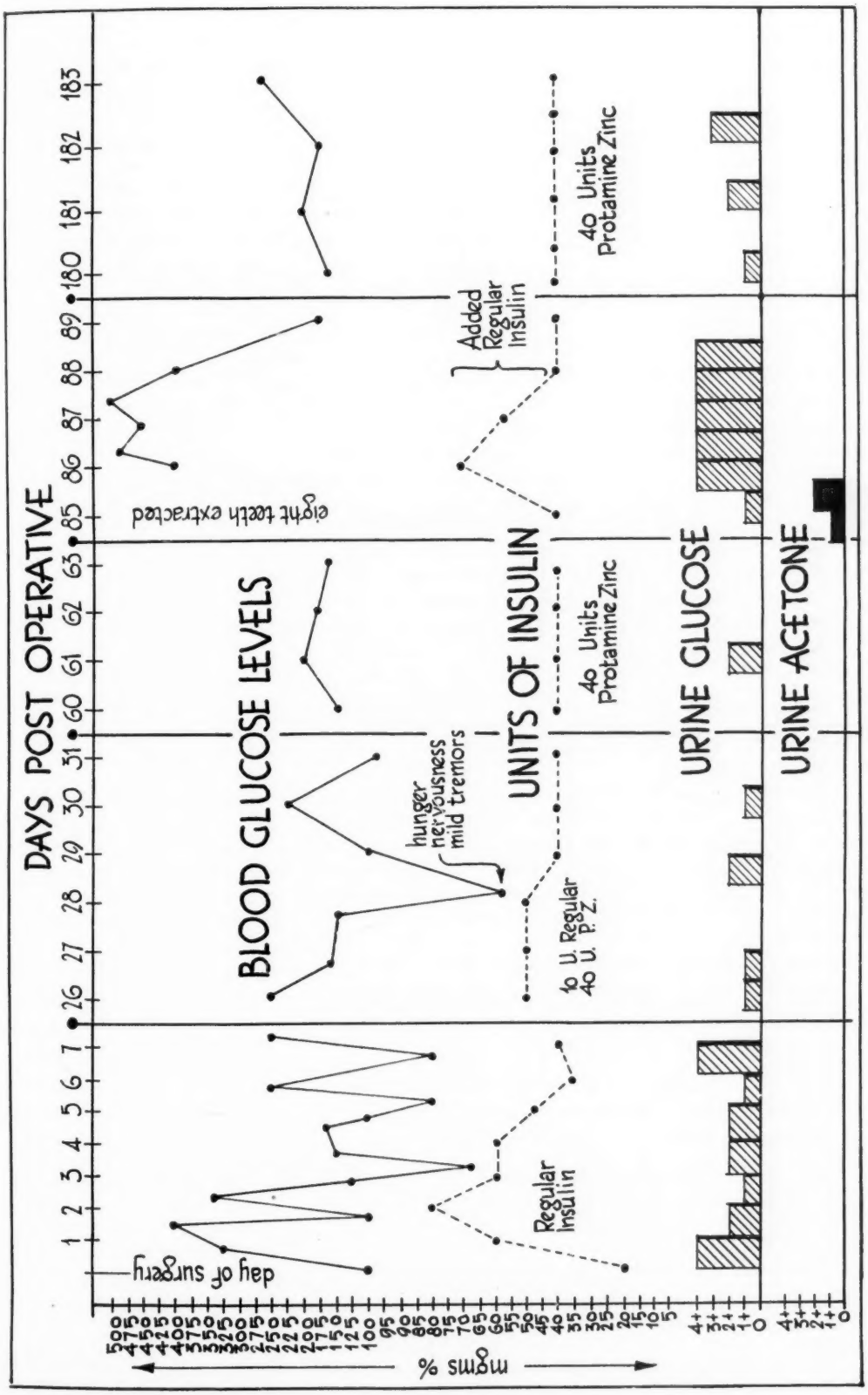

Chart 1.—Postoperative studies of diabetic state.

he did not consume the prescribed diet of 2,803 calories. On the day following the extraction, there were 4 plus sugar and 3 plus acetone in the urine and the blood glucose rose to 495 mg. per cent. He had a desire for large quantities of water and complained of frequency of urination. With only the addition of three small doses of regular insulin, 15 units each, given at six-hour intervals that evening and the next morning, in addition to intravenous glucose, the acetone rapidly disappeared from the urine. For several days thereafter he still had 4 plus sugar in the urine. Penicillin was administered until all signs of the inflammation had disappeared. The dentist was cautioned to be less radical. With the subsequent tooth extractions, the patient was placed on pencillin and no further evidence of acidosis occurred.

Although his diet has not been accurately calculated at home, this patient has been adequately maintained with daily morning doses of 40 units of protamine zinc insulin to date (Chart 1). The dietician gave him a list of foods and instructed him in how to estimate the portions. Apparently, this has been very satisfactory. The insulin has been administered by his wife or himself every morning. He was taught to test the urine daily for acetone rather than for sugar, since it was felt that the daily fluctuations of the urinary sugar would serve to confuse him rather than help him. He was instructed to seek medical attention if even a trace of acetone appeared in the urine.

Liver studies: The patient had been jaundiced for approximately one month prior to surgery. The serum bilirubin, which had risen to 20 mg. per cent preoperatively, did not begin to decrease until the seventh postoperative day. This delayed fall of the serum bilirubin was viewed with considerable anxiety at that time and raised doubts as to the patency of the choledochojejunostomy. On the seventh postoperative day a distinct brownish color was observed in the patient's liquid stools. From then on the serum bilirubin fell gradually and since the sixty-fifth postoperative day has been normal (Chart 2).

In spite of the complete common duct obstruction, the serum alkaline phosphatase attained only 14.9 King-Armstrong units preoperatively. This value followed the downward course of the serum bilirubin, reaching normal on the fiftieth postoperative day. From about the sixty-fifth postoperative day, it rose again, reaching a peak of 6 mg. per cent during the episode of mild acidosis described here. Since the ninetieth day it has remained normal (Chart 2).

The blood cholesterol values, including total and free cholesterol determinations, persistently varied within the wide range of normal. Just prior to and during the period of acidosis described here, the blood cholesterol reached the lower limits of normal, and the cholesterol esters less than normal. These values rose again, and by the ninetieth day were again normal (Chart 2). Blood lipid determinations could not be obtained at this institution, so the cholesterol determinations are being offered as a reflection of liver status and lipid metabolism (4, 12).

The cephalin flocculation, which had been 4 plus preoperatively, became negative on the thirty-fourth postoperative day and was consistently normal thereafter. The thymol turbidity test was normal before and after operation.

The serum amylase was found to be 54 mg. per cent on the day following surgery and varied between 18 and 75 mg. per cent during the ensuing six postoperative months.

The total proteins and albumin-globulin ratio remained normal.

The bromsulfalein test showed no retention in the sixth postoperative month.

Nutritional studies:

A. Diet: On the eighth postoperative day, the patient was being maintained entirely on oral feedings which consisted of a computed soft diet, low in fats. At that time 10 Gm. of pancreatin tablets were administered daily. Solid foods were started on the twelfth day and the pancreatin was increased to 16 Gm. daily to improve the assimilation of ingested food. The caloric intake was gradually increased to 2,803 calories, of which 404 Gm. were carbohydrates, 182 Gm. protein, and 51 Gm. fat. This was evidently sufficient for this patient in spite of the calculated 351 calorie loss in the stools. His basal requirement was computed at 1,800 calories. The additional calories were desirable to allow for some

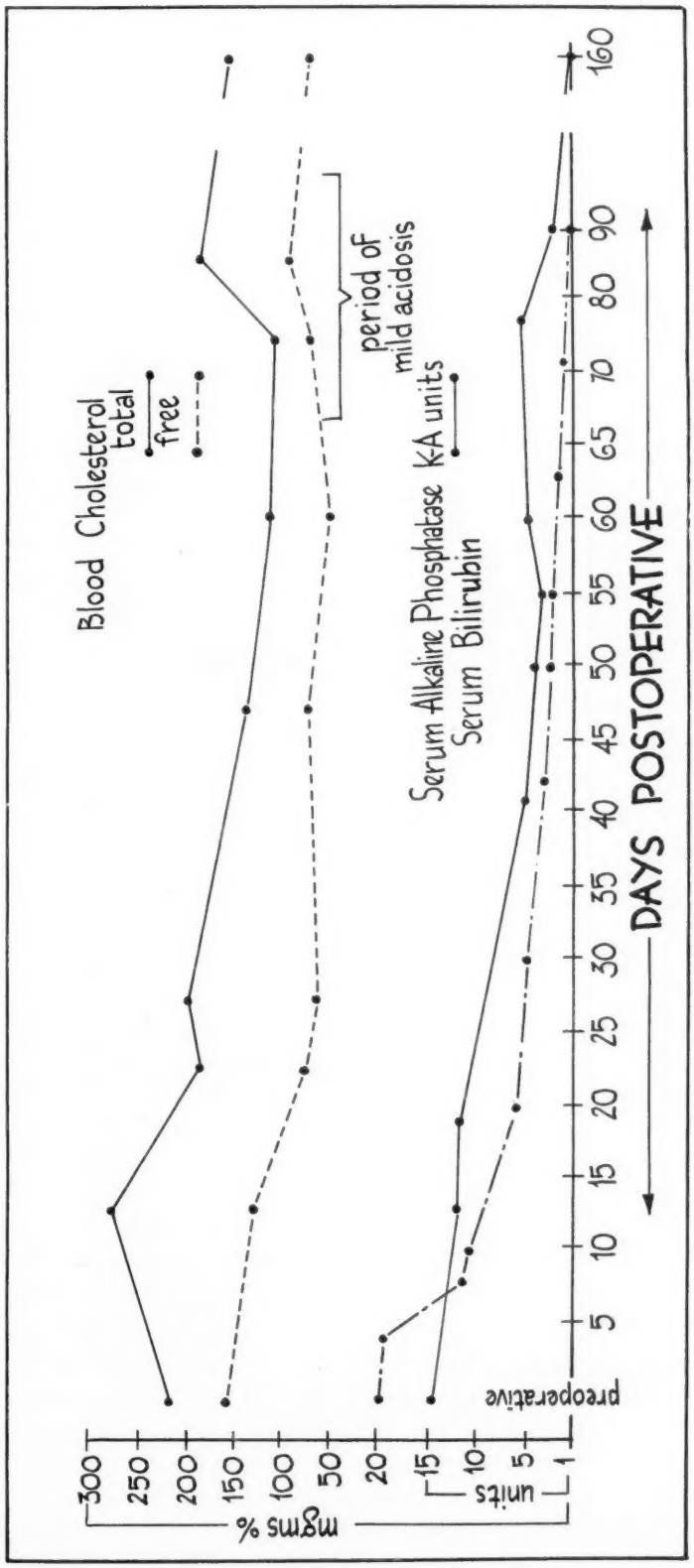

Chart 2.—Postoperative liver function studies.

TABLE III. NUTRITION AND STOOL ANALYSES

	15*	27*	49	55	80	180	187	AVERAGE FINDINGS WITH PANCREATIN	AVERAGE FINDINGS WITHOUT PANCREATIN
INTAKE									
Caloric intake	1950	2380	2803	2803	2803	2803	2803		
CHO (Gm.)	250	275	404	404	404	404	404		
Protein (Gm.)	150	160	182	182	182	182	182		
Fat (Gm.)	50	60	51	51	51	51	51		
Insulin (Units)	42 R.	35 P.Z.	40 P.Z.	40 P.Z.	40 P.Z.	40 P.Z.	40 P.Z.		
Pancreatin (Gm.)	10	16	16	0	16	16	0		
Methionine (Gm.)	3	3	3	3	3	3	3		
Body weight (Pounds)	160	150½	155	156	155	160	160		
STOOL ANALYSIS									
No. of stools daily	3-4	4	4	4	4	4	4		
Dry weight of stool specimens (Gm.)	73	60	95	157	81	151	196	128	176
Total fat (% Dry Weight)	45	37	33	46	35	23.2	34	30	40
Neutral fat (% Dry Weight)	2.7	3.3	1.6	1.4	4	1.98	9	2.8	5.2
Fatty acids (% Dry Weight)	42	34	31	45	31	21.2	25	27.6	35
Protein (% Dry Weight)	31	36	33	39	33	17.9	36	27.9	37.5

*Findings not considered in calculation of averages because serum bilirubin was still elevated.

activity, to compensate for loss in the stools, and to stimulate gain in lost weight. It was not until the forty-sixth postoperative day that the patient's appetite would permit this caloric intake. Since then his appetite has been excellent. Because of the inefficiency of fat utilization in all such patients, fats were given in the diet only to make the food palatable. Fortunately, the patient had always been fond of eggs, which made up a large part of the food intake. This guaranteed the choline intake so desirable in depancreatized individuals for liver protection.[1] Three grams of methionine were started on the fifteenth postoperative day and continued to date, for the same reason. On this diet the patient regained and maintained the preoperative weight of 160 pounds (Table III). Likewise, his pre-illness strength and endurance returned. During the third postoperative month, the patient went back to the light work of handy man about a naval officer's home.

B. Stools. During the first twelve days of the postoperative course, the patient had six to eight liquid stools daily. During the greater portion of this period he was receiving intravenous fluids and then liquid to soft diet orally. During this time he delivered very little bile and, of course, no pancreatic juice into the gastrointestinal tract. When solid food was started he settled down to three or four stools daily and has continued thus to date. These stools are of a mushy consistency, grayish brown in color, and have more than the usual offensive odor. However, fat droplets were not seen in any of the specimens. Although the pancreatin tablets were not taken during one seven-day period. the number of stools did not increase. Because the fat fraction of the diet has never been altered, no statement can be made as to the relationship of fat intake and number of stools.

Repeated stool analyses, after the serum bilirubin reached normal, revealed that this patient, while receiving pancreatin, delivered an average of 128 Gm. of dry fecal solids as compared to the average normal of 40 Gm. Of this total dry weight, 30 per cent was fat. Broken down into the fatty fractions: 27.6 per cent were fatty acids and 2.8 per cent were neutral fats. Protein made up 27.9 per cent of the total dry fecal solids (Table III).

The stool analyses performed during the third and sixth postoperative months indicated that 61.5 per cent of the ingested fat and 14.9 per cent of the ingested protein was lost in the stools or a daily loss of 351.5 calories. At no time were undigested muscle particles or straitions seen microscopically in any of the specimens. When the patient did not take pancreatin and the stool analysis repeated, the total fats increased to 40 per cent of the total dry solids, 5.2 per cent of which was neutral fat and 35 per cent fatty acids. The proteins also increased to 37.5 per cent of the dry stools.

DISCUSSION

Total pancreatectomy was performed in this case because the limit of the carcinoma of the head was not palpably distinguishable from the chronic pancreatitis in the body and tail of the gland, and there was no evidence of regional or distal metastases at the time. It is possible that soiling with cancer cells occurred during the biopsy procedure. That could account for the presence of residual disease five and one-half months later, although the pathologic report of carcinoma cells in the endothelial-lined spaces of the specimen may be the more reasonable explanation. We wonder whether biopsy should be performed at all, in spite of the possibility of removing a pancreas involved by chronic pancreatitis rather than carcinoma.[14]

In the reconstruction following the total pancreaticoduodenectomy in this case, the principles outlined by Pearse[5] were followed. The first part of the jejunum was joined to the common duct by end-to-end anastomosis. Approximately eight inches distally, the resected end of the stomach was anastomosed to the side of the jejunum (Fig. 2). Although drainage of the common duct and of the deperitonealized area of the pancreatic bed was not carried out in this instance, it is felt that it would be safer to drain.

As mentioned previously, the greatest fluctuations of blood glucose occurred during the first five postoperative days. This is consistent with the findings of other observers who feel that the depancreatized individual has suddenly become sensitive to insulin.[6, 7] An explanation of this sensitivity is still speculative. However, the sudden removal of the patient's major carbohydrate regulating mechanism, and the unknown degree of liver dysfunction due to chronic biliary obstruction in this case, must have played a part. The constant danger of hypoglycemia during the immediate postoperative period by an overzealous administration of insulin has been emphasized previously.[1, 6, 7, 8]

Comparable to the majority of other reported cases of total pancreatectomy in which the patients survived the immediate postoperative period,[1, 2, 3, 9, 10] a daily dose of 40 units of protamine zinc insulin was sufficient to sustain the carbohydrate metabolism and prevent ketosis on a diet of 2,803 calories of which 404 Gm. of carbohydrate were included. The excellent state of nutrition of this patient maintained on the diet described seems to contradict the opinion that depancreatized individuals require fairly small amounts of insulin because of their cachectic state.[1]

Like any ordinary human diabetic patient, this man did develop ketosis due to intercurrent infection. In this instance, as described here, the precipitating factor was a cellulitis of the jaw. It is interesting that the addition of comparatively small doses of regular insulin controlled this episode of acidosis.

During the course of the postoperative studies no attempt at deliberately precipitating ketosis was made by withdrawal of insulin, because of the danger involved. Furthermore, it was felt that no valuable data concerning acidosis, other than degree, would be obtained. Brunschwig and associates[11] and Dixon and co-workers[1] have already reported ketosis produced by insulin deprivation in such patients.

The foregoing liver studies indicated that all abnormal liver function tests returned to normal probably due to the relief of the extrahepatic biliary obstruction. Repeated determination over a period of six months showed no evidence of hepatic dysfunction. These findings are consistent with those previously reported.[1, 2, 6] Repeatedly normal serum alkaline phosphatase determinations in this patient further indicate lack of liver degeneration according to Canepa's investigations of fatty liver changes in dogs.[12] The administration of methionine, pancreatin, and eggs probably contributed to the protection of the liver against fatty degeneration.[1, 6]

One of the problems confronting the surgeon who manages a depancreatized individual is the maintenance of the nutritional state and, if possible, the restoration of the preoperative weight. Of the reported surviving patients, this is one of the few who regained and maintained preoperative weight. Not previously stressed in the literature is the patient's limited appetite, which may be an obstacle to increasing the dietary intake. In our case, the appetite definitely improved as the serum bilirubin fell and the hepatic function tests returned to normal. It was then possible to increase the caloric intake to the optimum calculated diet.

Of real value in increasing the assimilation of the ingested diet is the use of fairly large amounts of pancreatic extract. With the daily administration of 16 Gm. of pancreatin tablets it was shown, in this case, that the fat and protein loss in the stools was diminished by approximately 10 per cent. Unlike insulin, the administration of pancreatin may become optional if the fat and protein intake can be sufficiently increased to compensate for the caloric loss in the stool.

Of interest is the paradoxical presence of large quantities of fatty acids rather than neutral fats found in this patient's stools and those of cases previously reported. This has been explained as being due to the presence of fat-splitting enzymes in stomach and small bowel secretions. Another possible explanation is that the fat fractions may be excreted through the bowel wall.[4] At any rate, splitting of fat seems highly successful in spite of the absence of pancreatic enzymes.

Although the pancreas was totally removed, amylase has been consistently demonstrated in this patient's blood. In a case reported by Brunschwig the blood amylase was 71 units eight weeks after surgery,[13] but that patient has had metastases, which might exercise this function. On the other hand the presence of normal salivary glands could account for the amylase in the blood.

From the findings in the literature to date and the studies performed in this case it can be deduced that the management of a depancreatized individual during the immediate postoperative period and subsequently is not as formidable as one might imagine. As emphasized by Gaston,[6] the efforts should be directed toward the prevention of ketosis during the immediate postoperative period rather than toward rigid control of the blood sugar levels. Urine acetone determinations at six-hour intervals will furnish all of the necessary information during that time. When the patient is placed on a prescribed oral diet, morning urinary acetone determinations will indicate whether adequate control of the diabetic state is being obtained. Sugar alone in the urine is of no great moment. Furthermore, repeated stool analyses and liver function studies are superfluous as long as the weight and appetite remain good or improve.

The ease of management is particularly exemplified by this reported case of an uneducated Southern Negro laborer who has been carrying out the instructions as to diet, insulin, pancreatin, and daily urinalyses with ease. The repeated laboratory studies performed have been only an indulgence on his part to please us.

SUMMARY

A case of total pancreaticoduodenectomy for carcinoma of the pancreas is reported.

Postoperative physiologic studies, in this case, during a period of over six months are presented.

Simplicity of management postoperatively is suggested.

REFERENCES

1. Waugh, J. W., Dixon, C. F., Clagett, O. T., Ballman, J. L., Sprague, R. G., and Comfort, M. W.: Total Pancreatectomy, Proc. Staff Meet. Mayo Clin. **21**: 25-46, 1946.
2. Priestley, J. T., Comfort, M. W., and Radcliffe, J., Jr.: Total Pancreatectomy for Hyperinsulinism Due to an Islet Cell Adenoma: Survival and Cure at Sixteen

Months After Operation, Presentation of Metabolic Studies, Ann. Surg. **119:** 211-221, 1944.
3. Dixon, C. F., Comfort, M. W., Lichtman, A. L., and Benson, R. E.: Total Pancreatectomy for Carcinoma of the Pancreas in a Diabetic Person: Metabolic Studies, Arch, Surg. **52:** 619-639, 1946.
4. Cantarow, A., and Trumper, M.: Clinical Biochemistry, Philadelphia, 1945, W. B. Saunders Company, pp. 136-137, 149.
5. Pearse, H. E.: Should We Standardize the Reconstruction After Pancreaticoduodenectomy? SURGERY **20:** 663-665, 1946.
6. Gaston, E. A.: Total Pancreatectomy, New England J. Med. **238:** 345-354, 1948.
7. Goldner, M. G., and Clark, D. E.: The Insulin Requirement of Man After Total Pancreatectomy, J. Clin. Endocrinol. **4:** 194-197, 1944.
8. Dragstedt, L. R.: Some Physiologic Problems in Surgery of the Pancreas, Ann. Surg. **118:** 576-593, 1943.
9. Brunschwig, A.: Surgical Treatment of Carcinoma of the Body of the Pancreas, Ann. Surg. **120:** 406-416, 1944.
10. Whipple, A. O.: Radical Surgery for Certain Cases of Pancreatic Fibrosis Associated With Calcareous Deposits, Ann. Surg. **124:** 991-1008, 1946.
11. Rickets, H. T., Brunschwig, A., and Knowlton, K.: Diabetes in a Total Depancreatized Man, Proc. Soc. Exper. Biol. & Med. **58:** 254-255, 1945.
12. Canepa, J. F., Tanturi, C. A., and Banfi, R. F.: Experimental Study on Lipocaic, Surg., Gynec. & Obst. **86:** 341-356, 1948.
13. Brunschwig, A., Ricketts, H. T., and Bigelow, R. R.: Total Pancreatectomy, Total Gastrectomy, Total Duodenectomy, Left Adrenalectomy and Omentectomy in a Diabetic Patient, Recovery, Surg., Gynec. & Obst. **80:** 252-256, 1945.
14. Brunschwig, A.: The Surgery of Pancreatic Tumors, St. Louis, 1942, The C. V. Mosby Company, pp. 282-286.

PARTIAL ESOPHAGECTOMY WITH END-TO-END ANASTOMOSIS IN THE POSTERIOR MEDIASTINUM

An Experimental Study

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END-TO-END anatomosis of the esophagus is the procedure of choice for correction of atresia of the esophagus. In some patients with this congenital anomaly, the esophageal ends may be separated 3 to 4 cm., and in such instances suturing the ends of esophagus together would result in considerable tension on the anastomosis.[1] We felt that a study of end-to-end anastomosis of the esophagus, under varying degrees of tension, should be performed on animals in the laboratory to determine the safe limits of such a procedure. Information concerning this problem might demonstrate the feasibility of resecting short, benign strictures of the esophagus and performing end-to-end anastomosis. A similar procedure might also prove of value in treating small carcinomas of the esophagus.

Successful resection of the thoracic esophagus and end-to-end anastomosis in dogs was accomplished by Dobromysslow[2] in 1901, and at later dates by Sauerbruch,[3] Omi and Karasawa,[4] and Enderlen, Hotz, and Porzelt.[5] In 1923, Miller and Andrus,[6] on the basis of the experimental reports just mentioned and results of their own experiments, concluded that only limited resections of the esophagus were feasible. Failures were due to (1) lack of firm tissue, that is, submucosa, for the suture to grasp; (2) difficulty in avoiding a destructive amount of tension; and (3) necrosis resulting from freeing the esophagus from its bed. The solution of Miller and Andrus to this problem was to mobilize the stomach and bring it into the chest for esophagogastric anastomosis—a relatively commonplace procedure today.

By 1934 no additional progress had been made. In a survey of the problem, Ochsner and Owens[7] reasoned that, "Whereas the ideal method for relieving esophageal obstruction would be removal of the diseased portion and reconstruction of the esophagus in the posterior mediastinum, the operation is attended by an extremely high mortality and is therefore not feasible or justified."

It was considered advisable to revaluate the problem of intrathoracic anastomosis of the esophagus in the laboratory animal, using, in so far as was practicable, the same technique used by one of us[1] in the treatment of esophageal atresia.

The results obtained in thirty dogs, operated upon between November, 1946, and May, 1947, suggest that considerable portions of the intrathoracic esophagus can be resected, and end-to-end anastomosis performed successfully, with a lower mortality rate than was previously considered possible.

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EXPERIMENTS

Dogs were used as subjects in a series of thirty experiments. There was considerable variation in sizes of the animals (5.9 to 16.8 kilograms). Due to these differences in animals, it became important to establish a method of measuring the length of the thoracic portion of the esophagus. This was taken to be the distance from the top of the first rib to the mid-point of the esophageal hiatus.

Preoperative preparation consisted of withholding food for twenty-four hours and liquids for twelve hours. Intravenous nembutal was used for anes-

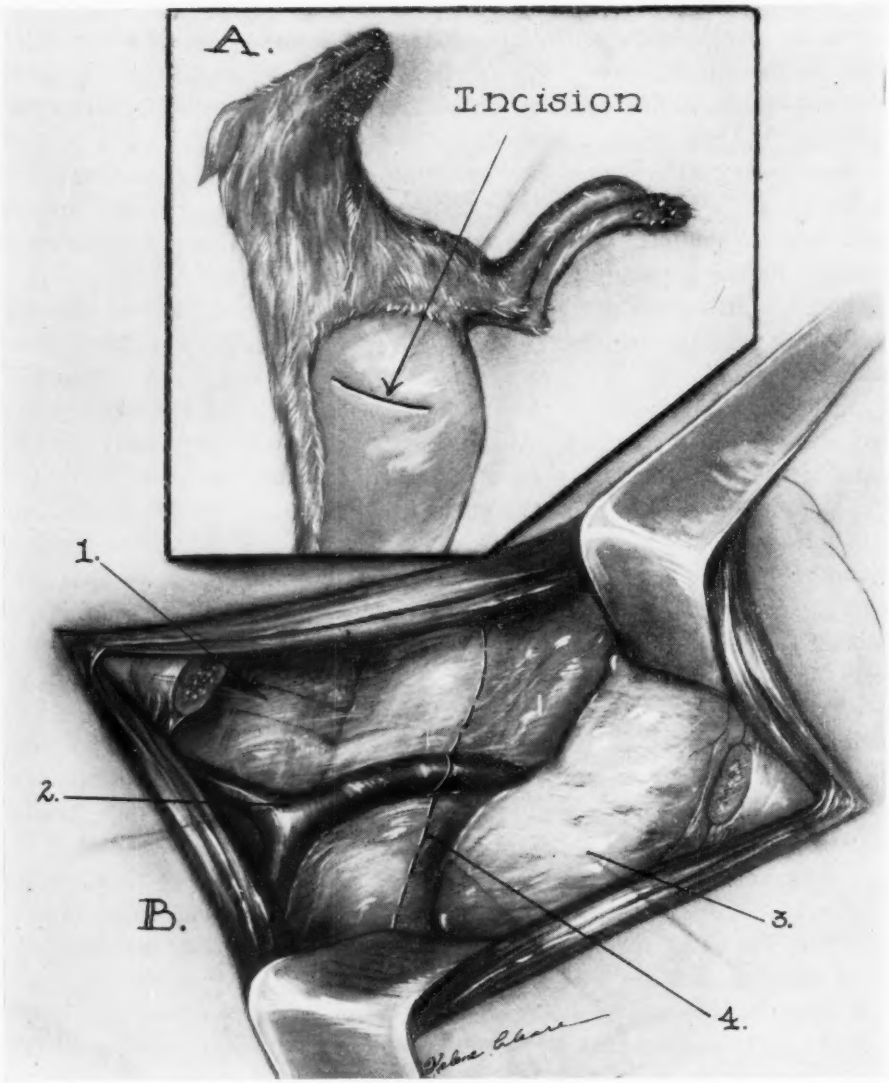

Fig. 1.—*A*, Drawing indicating type of incision used. *B*, Drawing of operative field before azygos vein is ligated and divided. (*1*) Vertebral bodies; (*2*) azygos vein; (*3*) collapsed lung; (*4*) line of incision of mediastinal pleura.

thesia, following which an endotracheal tube was inserted and respirations were controlled with a positive pressure pump.

Various types of transpleural thoracotomy incisions were used. In general, a posterolateral approach with the removal of one rib provided adequate working exposure. The side chosen depended on the portion of the esophagus to be removed. For the lower third, the left-sided approach proved more satisfactory; for the upper two-thirds, the right was used except in four instances, where the anastomosis was performed through the left chest just below or lateral to the arch of the aorta.

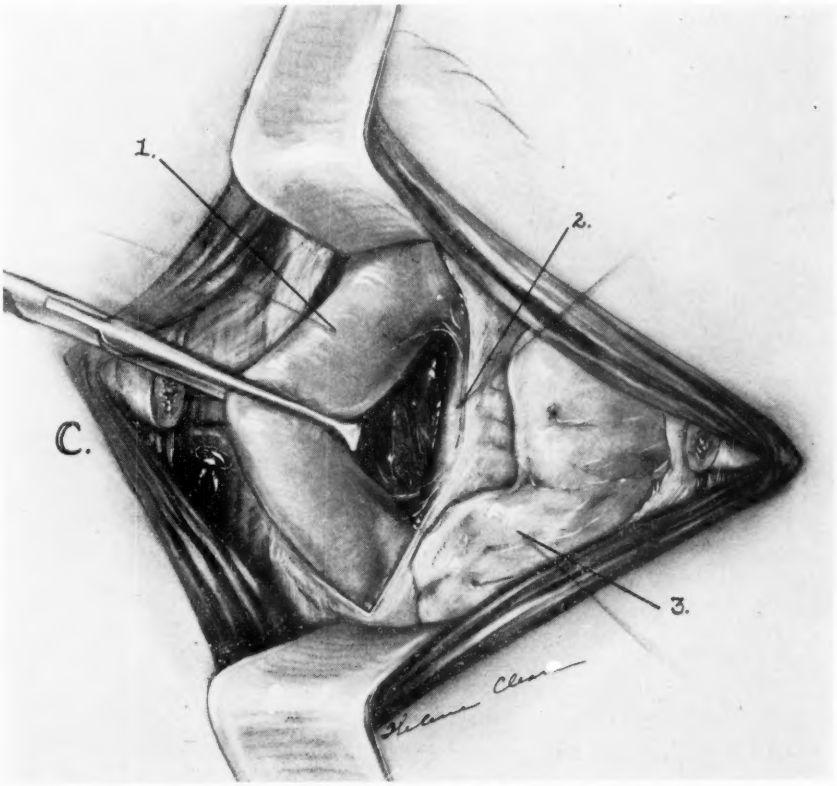

Fig. 2.—*C*, Drawing indicating the beginning of freeing the esophagus. (*1*) Esophagus, (*2*) trachea, (*3*) collapsed lung.

Upon opening the chest the lung was allowed to collapse and was walled off with moist gauze packs. The parietal pleura was incised anterior to the esophagus at the desired level, and dissected posteriorly to provide a flap, which was preserved for subsequent closure over the anastomosis. On the right side the azygos vein was ligated and divided if it interfered with subsequent exposure (Fig. 1). The major ramifications of the vagus nerve were preserved intact and retracted anteriorly.

At the level of the proposed resection, the denuded esophagus was grasped with an Allis clamp and carefully freed from its bed, care being taken to avoid injury to the thoracic duct, aorta, and both venae cavae (Fig. 2). The seg-

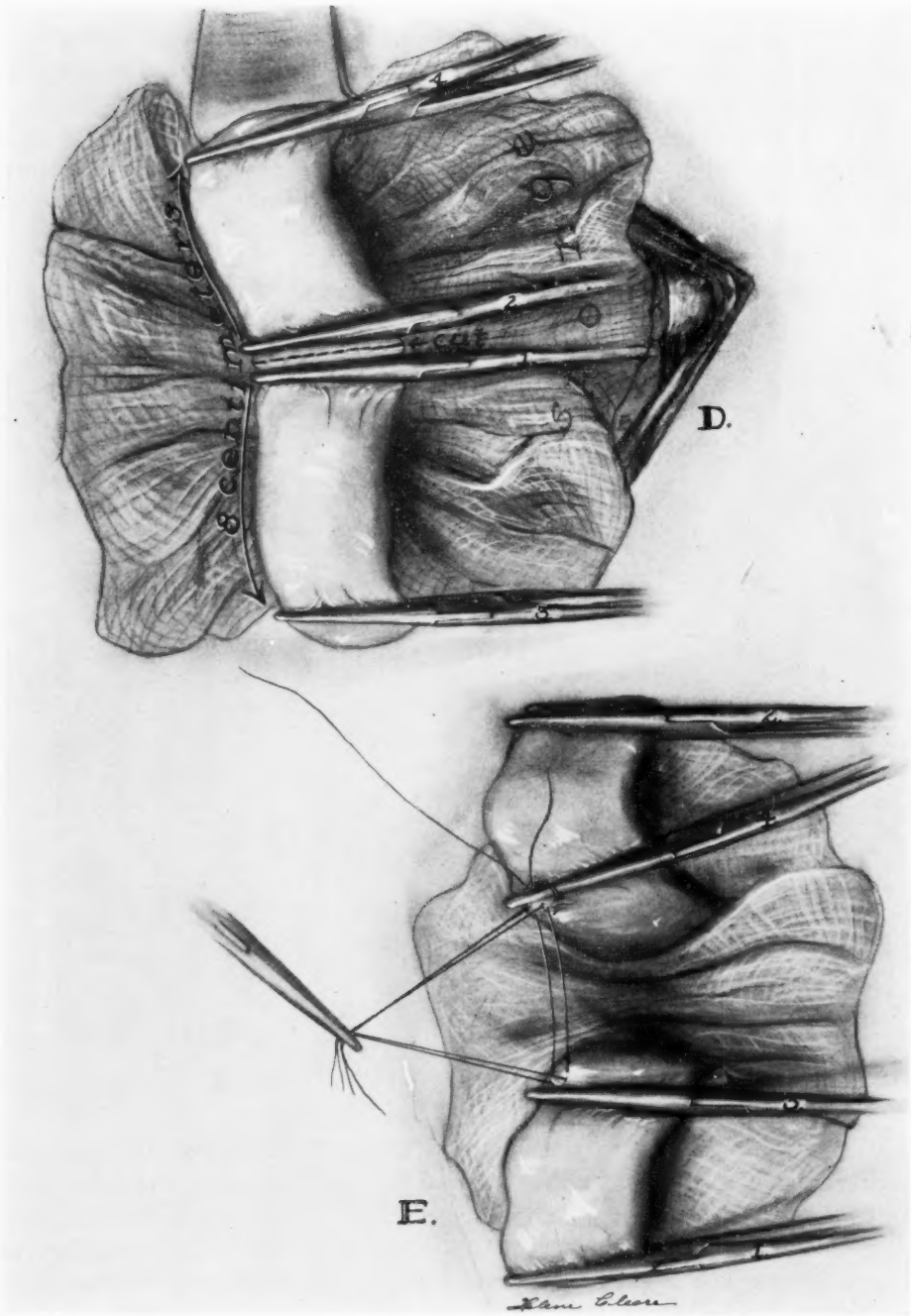

Fig. 3.—*D*, Drawinng of freed esophagus. This esophagus is cut between clamps *1* and *2*. Clamps *3* and *4* are at the limits of the resection. *E*, Drawing of operative field after the esophagus has been divided. First row of interrupted sutures is placed through the muscular coat and submucosa.

mental vessels entering posteriorly were ligated and divided. An attempt was made to preserve vessels beyond the anticipated limits of the resection. The esophagus was freed in such a fashion that any fibrous bands restricting it were divided, whereas the vessels were left to be stretched and elongated by straightening their course. This dissection, close to the esophagus, was carried well above the thoracic inlet in each case without any apparent ill effect. In dissecting the lower third of the esophagus, care was exercised to avoid opening the opposite pleura.

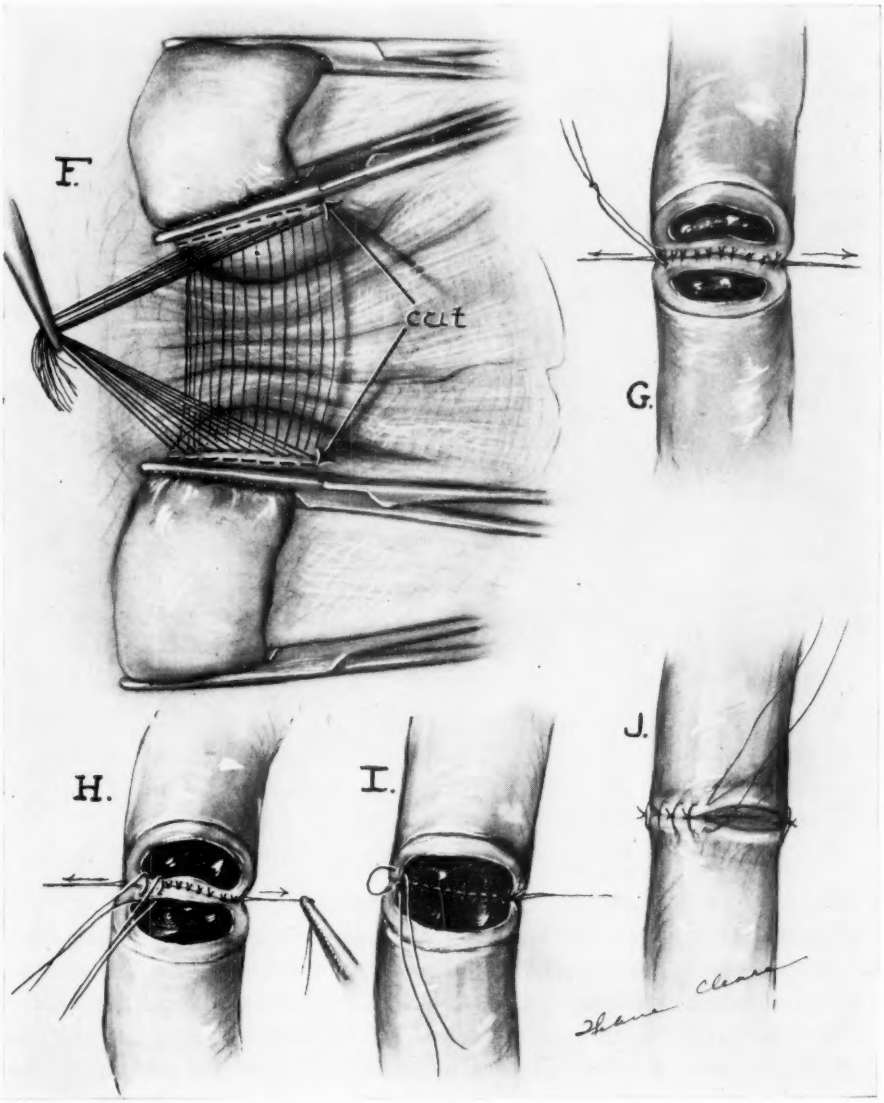

Fig. 4.—*F*, The first row of sutures has been placed. The esophagus is cut across between the clamps and the sutures. *G*, The first row of sutures has been tied. *H*, Sutures being placed to approximate the mucosa. *I*, The mucosal layer of sutures has been tied posteriorly. *J*, The anastomosis is being completed by the row of sutures approximating the muscular coat.

The esophagus was then walled off with saline-moistened sponges, doubly grasped with straight Kocher clamps, and divided at the mid-point of the proposed site of resection (Fig. 3, *D*). By traction on the clamp handles, the assistant exposed the posterior walls to the operator's view. A small, straight Kocher clamp was then placed at each limit of the resection. A row of interrupted 0000 braided black silk sutures was next placed just beyond these clamps. This first row included the full thickness of the muscular coat and some of the submucosal layer. Fifteen to twenty sutures, placed at 2 to 3 mm.

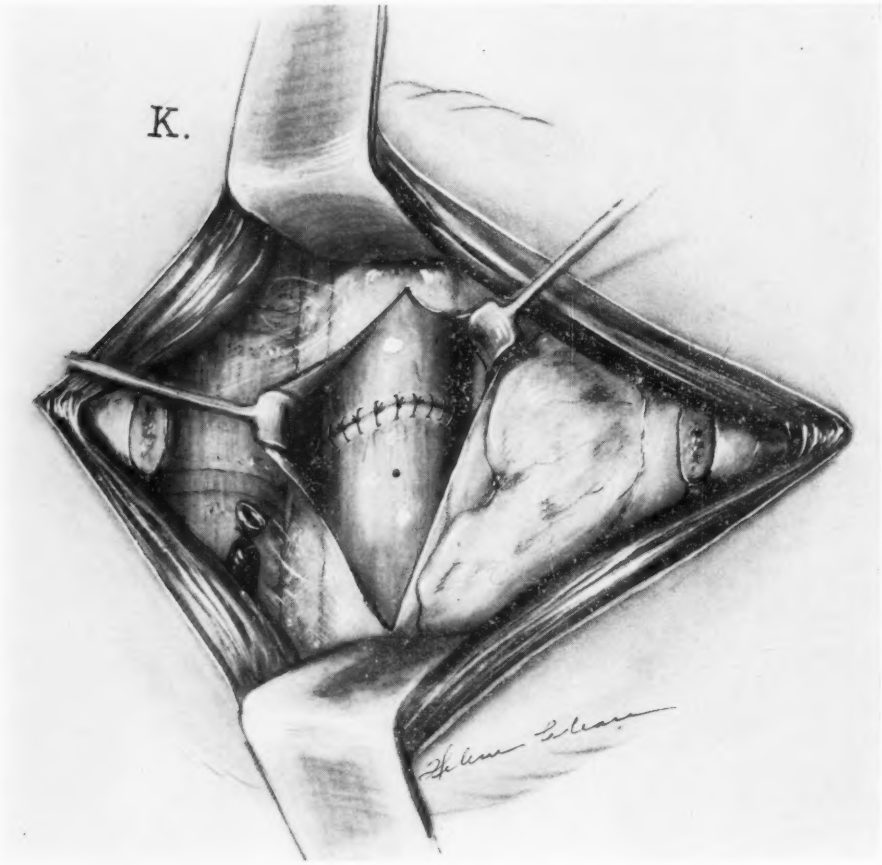

Fig. 5.—*K*, Drawing of completed anastomosis.

intervals, were used to complete this first layer (Fig. 3, *E*). The segments of esophagus were then brought together by gentle traction on the clamps and by see-sawing the multiple sutures back-and-forth until the two Kocher clamps were approximated, following which the Kocher clamps and portion of esophagus to be resected were cut free (Fig. 4, *F*). The row of sutures was then tied (Fig. 4, *G*). A second layer of interrupted 0000 silk sutures was then placed in the mucosal layer with all knots being tied within the lumen (Fig. 4, *H* and *I*). By continuing the row of interrupted sutures to the muscular layer, the anastomosis was completed (Fig. 5).

At the end of each operation in the series the lung was re-expanded by positive pressure and the chest was closed in layers with continuous 000 chromic catgut.

Postoperatively, the animals were given no supportive fluid therapy or chemotherapy. They were offered water and milk on the first postoperative day, but no solid food until the tenth. During this period they were observed daily, and with but three exceptions exhibited no major difficulties with swallowing. On the eleventh day they were given full rations, including meat and dog biscuits.

In the first animals, in which over 50 per cent of the intrathoracic esophagus had been resected, there was obviously undesirable tension on the suture line. This tension increased considerably during diaphragmatic contraction. Diaphragmatic contractions also caused the line of anastomosis to move up and down as much as 3 cm. Such movements would obviously interfere with the important "sealing off" processes which are so desirable in the early postoperative period. To obviate the motion produced by respiration and at the same time to relieve part of the tension on the esophageal suture line, two additional steps were taken in some of the later experiments.

First, two or more traction sutures were placed through the muscularis and submucosa of the distal segment approximately 1 cm. below the line of anastomosis, and thence through the prevertebral fascia about 1 cm. above the suture line. When these were tied, part of the tension on the suture line was relieved and the site of anastomosis was sufficiently fixed so that it no longer moved with each diaphragmatic contraction. In the seven dogs in which such traction sutures were used there were no deaths, although in five of these animals more than 50 per cent of the intrathoracic esophagus had been resected.

Second, the phrenic nerve was crushed on the ipsilateral side, thus temporarily paralyzing one-half of the diaphragm. No deleterious effect on the animals' convalescence was observed. While the point could not be proved, it was felt that diminution of diaphragmatic movements on the operative side aided in healing of the esophageal wound.

Though extrapleuralizing the anastomotic site is obviously a sound procedure, this step was purposely omitted in the first twenty-two operations. In the last eight animals it was carefully carried out, using interrupted silk sutures to close all defects in both pleurae. There were no deaths in this latter group.

RESULTS

Two of the dogs died of respiratory failure within two hours of operation and are therefore classed as anesthetic deaths. One dog, improperly prepared, regurgitated into the chest when the esophagus was opened, and succumbed two days later of putrid empyema. One animal died of putrid empyema secondary to perforation of the esophagus at the site of anastomosis, and at autopsy was found to have a 3 by 3 inch gauze sponge in the right pleural cavity and a completely collapsed right lung.

In the twenty-six remaining animals, which were available for study, there were six deaths because of breakdown of the anastomosis which led to medias-

TABLE I. SUMMARY OF EXPERIMENTS

DOG NO.	LENGTH OF SEGMENT RESECTED (IN CM.)	PER CENT OF INTRA-THORACIC ESOPHAGUS RESECTED	TRACTION SUTURES EMPLOYED	PHRENIC NERVE CRUSH	EXTRA-PLEURALIZED	DAYS SURVIVAL	CAUSE OF DEATH	DIAMETER OF ESOPHAGUS AT SUTURE LINE	PERFORATION
1	2.5	16.6	2	No	No	59	Sacrificed	Normal	No
2	5.0	22.7	2	No	No	88	Distemper	2 cm.	No
3	9.0	60.0	3	No	No	52	Sacrificed	Normal	No
4	6.0	45.0	No	No	No	2	Aspiration		Yes
5	12.0	66.6	No	Yes	No	11	Sacrificed	Normal	No
6	10.0	52.7	No	Yes	No	82	Sacrificed	Normal	No
7	11.0	55.0	No	Yes	No	26	Sacrificed	Normal	No
8	10.0	55.0	No	No	No	125	Sacrificed	2 cm.	No
9	10.0	45.0	No	No	No	31	Sacrificed	1.75 cm.	No
10	11.0	55.0	No	Yes	No	21	Sacrificed	Normal	No
11	16.0	80.0	No	No	No	5	Empyema		Yes
12	10.0	66.6	No	Yes	No	5	Empyema		Yes
13	9.0	50.0	No	No	No	1½	Empyema		Yes
14	8.0	40.0	No	No	No	0	Anesthesia		
15	8.0	50.0	No	No	No	2	Empyema		Yes
16	8.0	50.0	No	No	No	76	Sacrificed	Normal	No
17	8.5	47.2	No	No	No	87	Sacrificed	Normal	No
18	9.0	60.0	No	No	No	79	Sacrificed	Normal	No
19	10.0	66.6	No	No	No	3	Dehiscence		Yes
20	8.0	53.3	No	No	No	4	Empyema		Yes
21	6.0	50.0	No	No	No	0	Anesthesia		
22	8.0	50.0	No	No	No	3	Empyema		Yes
23	7.0	50.0	No	No	Yes	62	Sacrificed	1.8	No
24	8.0	55.0	No	No	Yes	63	Sacrificed	1.7	No
25	9.0	47.5	No	No	Yes	33	Sacrificed	1 cm.	No
26	9.0	50.0	No	No	Yes	9	Sacrificed	Normal	No
27	9.5	65.5	2	No	Yes	24	Sacrificed	2 cm.	No
28	8.0	55.0	2	Yes	Yes	54	Sacrificed	1.7 cm.	No
29	11.0	55.0	2	No	Yes	3	Sacrificed		No
30	6.5	35.9	1	Yes	Yes	33	Sacrificed	1 cm.	No

tinitis and bilateral empyema. The amounts of esophagus which had been resected from these six dogs were 50, 50, 54, 67, 67, and 80 per cent, respectively. The deaths occurred between the second and fifth postoperative days.

Twenty dogs survived the operation and appeared to be in satisfactory postoperative condition until the time of their sacrifice. Three were sacrificed early, on the third, ninth, and eleventh days, respectively. The remainder were observed for periods varying from twenty-one to as long as 125 days (see Table I). In this group of twenty survivors an average of 51.5 per cent of the intrathoracic esophagus had been resected.

PATHOLOGIC FINDINGS

An autopsy was performed on each animal. Photographs of the esophagus in situ and of the portions of esophagus containing the suture line were taken in some cases (Fig. 6). Specimens of representative results were fixed in 10 per cent formalin, and sections through the line of anastomosis prepared.

In each case, on opening the chest, adhesions were found between the expanded lung and the line of thoracotomy. The lung was also adherent to the unpleuralized esophagus in those cases in which the anastomosis had not been covered with pleura.

In one case there was slight dilatation of esophageal segment proximal to the anastomosis. In this dog and in one other there was a significant stricture at the anastomosis; the lumen at the suture line measured 1 cm. in diameter in both instances. There were no other significant strictures.

In one dog, sacrificed at nine days, there was a single shallow posterior perforation which was walled off and may have been caused by a single museu-

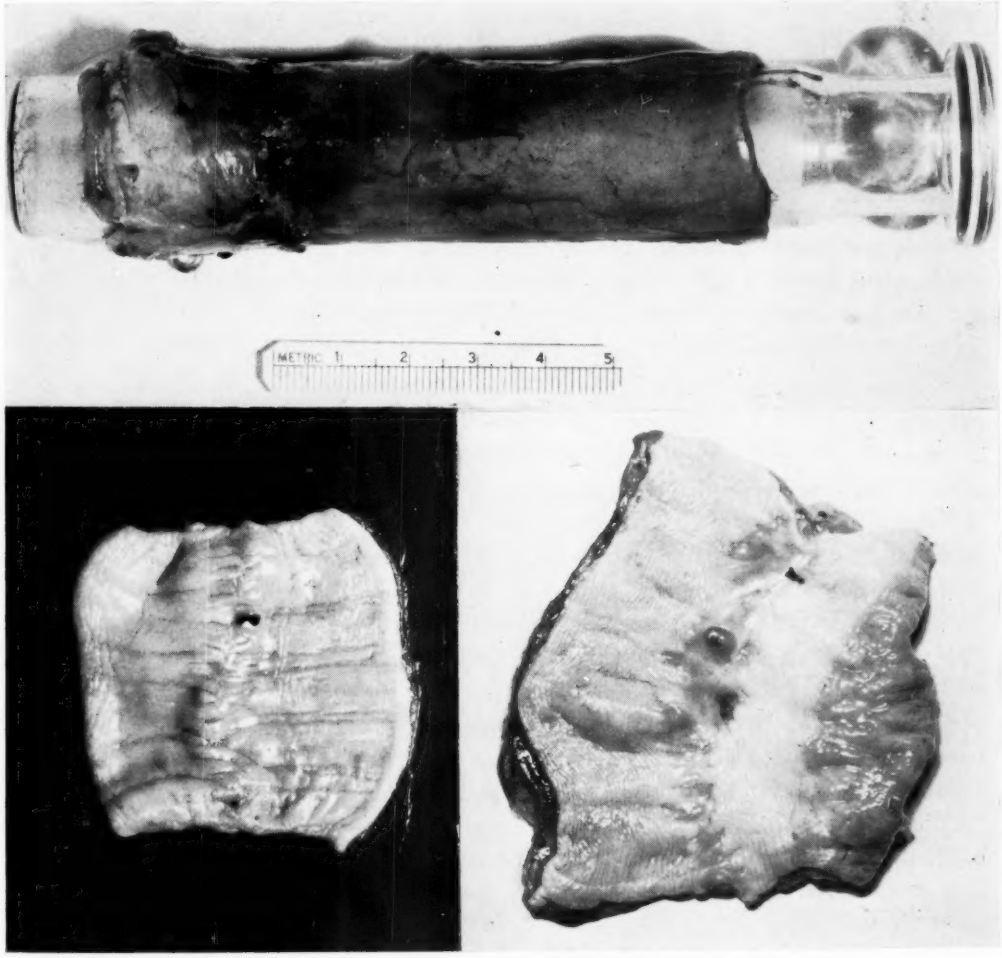

Fig. 6.—*A*, Specimen removed four months after anastomosis of the esophagus. There was no significant stricture. *B*, Specimen two months after anastomosis. One mucosal suture remains. (No mucosal sutures remained in any animal after ten weeks.) *C*, Specimen one month after anastomosis. There are two mucosal sutures remaining. One deep suture is also exposed.

laris suture which had inadvertently passed through all layers of the wall of the esophagus.

Upon opening the esophagus longitudinally, the interior of the anastomosis could be inspected. In all cases in which 50 per cent or more of the intrathoracic esophagus had been resected, the mucosal layer had not entirely healed per primam but had separated in part or in toto from a few millimeters to

as much as 1.5 cm. In the animal sacrificed at three days this separation was already beginning to take place. As the silk stitches cut through, the intervening space was filled in with thick exudate which later became fibrous and appeared to seal off the anastomosis in a satisfactory fashion.

Specimens examined at nine to eleven days showed that the anastomotic line was completely sealed by epithelium which had grown in from the adjacent mucosal edges. In the animals sacrificed at ten weeks or more from operation, none of the mucosal silk sutures remained. The sutures in the muscular layer, on the other hand, had remained intact. In three cases, where the musculature stitches had not been cut on the knots, the loose ends of one suture in each animal had worked through the new epithelium of the esophagus and had formed a small, superficial ulceration. However, there was no evidence of fistulous tract or perforation at these points, and it is presumed that these exposed sutures would ultimately have sloughed into the lumen of the esophagus. Microscopic sections taken through the suture line in animals four to eight weeks after operation demonstrated little inflammatory reaction and very little increase in connective tissue.

SUMMARY

A technique for resecting a portion of the intrathoracic esophagus and performing an end-to-end two-layer anastomosis with interrupted silk sutures is presented. In a series of thirty dogs which were subjected to such a procedure there were twenty survivals, and in these an average of 51.5 per cent of the thoracic esophagus had been resected. There was no failure in any animal in which less than 50 per cent of the intrathoracic esophagus had been resected.

In order to decrease the incidence of fatal complications, three steps were thought to be of real value after completion of an esophageal anastomosis: (1) placement of traction sutures to relieve tension and to fix the anastomosis; (2) phrenic nerve crush to inactivate part of the diaphragm and relieve the periodic increase in tension during inspiration; and (3) careful closure of the overlying pleura to promote early sealing of the anastomotic site and produce a protective barrier against any minor leakage.

This study indicates that considerable portions of the esophagus can be excised, that end-to-end reconstruction can be made, and that such procedures can be followed by high percentages of success.

REFERENCES

1. Swenson, O.: End-to-end Anastomosis of the Esophagus for Esophageal Atresia, SURGERY **22**: 324-334, 1947.
2. Dobromysslow, W. D.: Ein Fall von transpleuraler Oesophagotomie in Brustabschnitte, Wratsch. 1900, No. 28, Ref. in Centralbl. f. Chir. **28**: 18, 1901.
3. Sauerbruch, F.: Die Chirurgie des Brustteils der Speiseröhre. Eine experimentelle Studie, Beitr. z. klin. Chir. **46**: 405-494, 1905.
4. Omi, K., and Karasawa, Z.: Beitrag zur Chirurgie der Speiseröhre, Deutsche Ztschr. f. Chir. **124**: 574-604, 1913.
5. Enderlen, Hotz, and Porzelt: Beitrage zur Chirurgie des Oesophagus, Ztschr. f. d. ges. exper. Med. 3: 108-121, 1914.
6. Miller, R. T., and Andrus, W. D. W.: Experimental Surgery of the Thoracic Esophagus, Bull. Johns Hopkins Hosp. **34**: 109-114, 1923.
7. Ochsner, A., and Owens, N.: Antero-thoracic Esophagoplasty for Impermeable Stricture of the Esophagus, Ann. Surg. **100**: 1055-1091, 1934.

CARCINOMA OF THE CERVICAL ESOPHAGUS WITH ONE-STAGE TOTAL ESOPHAGEAL RESECTION AND PHARYNGOGASTROSTOMY

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CARCINOMA of the cervical esophagus was first attacked surgically in 1877 by Czerny.[1] He resected 6 cm. of cervical esophagus and sutured the distal opening to the lower end of the wound using it for feeding purposes. The patient recovered postoperatively but died of recurrent cancer fifteen months later. Mikulicz[2] in 1844 resected the cervical esophagus for cancer; the postoperative fistula was repaired by a plastic flap which was successful and his patient ate solid food ten days after operation. However, recurrent cancer caused the death of this patient sixteen months later. VonHacker[3] in 1908 reviewed the literature, presenting a collected series of twenty-five cases with an operative mortality of 48 per cent. The longest survival in this group was sixteen months. He presented his own case in which a gastrostomy was followed by resection of the cervical esophagus and larynx. Later a two-stage plastic procedure using a skin tube restored the continuity of the cervical esophagus. Although the final result was not recorded, the patient was living and well sixteen months after operation. Lane[4] in 1911 reported the resection of the cervical esophagus using a skin flap based in the left side of the neck to close the defect. The pharynx was sutured to the upper end of the flap and the distal end of the esophagus to the lower end of the flap. Following the complete repair, recurrent cancer caused a fatal hemorrhage by invasion of the carotid artery. Eggers[5] in 1925 and Torek[6] in 1926 both reported cases of resection of the cervical esophagus and larynx for cancer. Both these patients died shortly after operation of the disease. Evans[7] in 1934 was quoted by Turner as having a twenty-three year cure of cancer of the cervical esophagus following radical excision of both the cervical esophagus and larynx. Trotter[8] in 1937 was able to report a ten year surgical cure following extirpation of the cervical esophagus and plastic repair.

The earliest attempts at esophageal surgery which were esophagotomies for foreign bodies may be reviewed in the excellent article by Watson,[9] 1942. He reported three cases of carcinoma of the cervical esophagus. The first, a 70-year-old man, was alive and in good health 10½ years after the lesion had been surgically exposed with its local nodal involvement and radon seeds installed followed by roentgen therapy.[17] However, similar treatment in five other patients did not influence their fatal termination. Watson[9] also quoted Nielsen as having reported in 1940 a 48-year-old woman who was symptom-free for 6½ years after receiving roentgen therapy for carcinoma of the cervical esophagus. Watson's[9] second case was that of a 69-year-old man with carcinoma of the first portion of the cervical esophagus who was treated by roentgen

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therapy. The initial edema of the trachea required tracheotomy. However, the patient is reported as having relative freedom from dysphagia for more than 10 years.[17] In his third reported case, Watson[9] followed the method of attack as suggested by Trotter,[8] in which carcinoma of the first portion of the cervical esophagus was treated by excision and exteriorization of the tumor-bearing portion of the esophagus over a wide rectangular skin flap based on the left side. Complications involved necrosis of the exteriorized portion of the esophagus and, in attempting to maintain communication between the pharynx and esophagus, stricture developed. This stenosis became complete and required plastic reconstruction. The patient was reported as well seven years after excision of the esophagus.[17]

Wookey[11] in 1942 presented four cases. The first was in the retrocricoid region extending to involve the laryngeal aperture and the left pyriform fossa. Laryngectomy and removal of the cervical esophagus (it was resected 1½ inches below its upper end) were done with reconstruction by use of a rectangular skin flap based on the right side. This reconstruction was completed as a second stage. The patient died 2 years later of cervical metastasis. The second case involved the lower pharynx and left pyriform fossa. Since the tumor did not involve the larynx it was saved and removal of the hypopharynx and cervical esophagus with repair as in the first case was done. It is stated that the patient was in good health 2 years later. Cases 3 and 4 involved the upper end of the cervical esophagus in the retrocricoid region but did not involve the larynx and both patients received excisional surgery as in the second case with plastic skin tube reconstruction. The third patient died of local cervical recurrence of carcinoma in 19 months and the fourth was reported as well 7 months later.

This résumé of the literature reveals that, in the main, surgery of carcinoma of the cervical esophagus deals with local excision and plastic repair. There is obviously a high local recurrence rate probably in the esophagus and surely in the draining lymph nodes. Bricker and associates,[13] 1948, presented clearly the necessity for a radical bilateral neck resection. This basic surgical principle of excision of involved lymph nodes draining any carcinoma has apparently in the past in surgical excision of carcinoma of the cervical esophagus received no attention. They further present an ingenious procedure by use of a pedicle tube flap graft which is anastomosed directly to the thoracic esophagus in the superior mediastinum.

The following case of esophageal carcinoma at the level of the cricoid cartilage in which a one-stage total esophagectomy and pharyngogastrostomy was done is presented.

A 68-year-old white man complained of dysphagia for two years. At first this difficult swallowing was not constant, but came and went. As time went on it became more constant. It finally became painful to swallow even liquids. On swallowing, the patient complained of pain radiating out both shoulders and down the arms to the tips of the fingers. He also noted definite pain over the episternal notch. Immediately to the left of the midline in the episternal region there was a spot which when pressed could evoke the painful part of this syndrome. During the last year he also complained of several episodes of indigestion which

consisted of upper abdominal discomfort particularly on the right side just under the right rib margin. Recently he had regurgitated food on several occasions. He had lost fourteen pounds in the past six months. Over a period of time this patient had been to numerous physicians and also had had barium studies of the upper esophagus, and no diagnosis was made. He was finally labeled a psychoneurotic. Being dissatisfied with this diagnosis, his doctor referred him to another for the investigation of this diagnosis. The report* was as follows:

For the purpose of determining the functional element which may be present in this syndrome of pain on swallowing, the patient was given intravenous pentothal in an amount to bring him to a state of unconsciousness without abolishing the swallowing reflex. He was then given water to drink and the patient exhibited every evidence of discomfort both locally and in the arms at this time. He could not remember the procedure very well for fifteen minutes after it was instituted and, therefore, presumably conscious premeditation can be ruled out as well as an emotional overlay.

As a result of this examination, it was felt that the patient had an organic lesion in or around the cervical esophagus. The patient was then referred to another doctor for roentgenographic studies of the upper esophagus. This report† was as follows:

The esophagus showed evidence of esophagitis, most marked at the thoracic inlet. The appearance suggested a filling defect of the esophagus at the level of the first thoracic vertebra.

At this point the patient was referred for esophagoscopy which revealed a lesion starting immediately as the inferior constrictor was passed. This was a raised, irregular area on which there were numerous polypoid-like projections. The lesion appeared to extend down the cervical esophagus for a distance of approximately 2 inches. Biopsy revealed a squamous-cell carcinoma. Careful investigation of the pyriform sinuses, the arytenoids, the laryngeal aperture, and trachea revealed no evidence of any involvement or fixation.

In planning the removal of this lesion, it was felt that, in view of the recurrence rate, the esophagus should be removed widely beyond each end of the border of the lesion. From experience of carcinoma of various portions of the thoracic esophagus, we have learned that the lesion was always found to extend further along the esophagus by esophagoscopy than reported by roentgenographic studies, and when the lesion was removed it was more extensive than expected from esophagoscopy. This meant that in this patient the upper limit of resection should be the hypopharynx. The lower limit would of necessity be just above the aortic arch for the lower border of the lesion was at approximately the superior thoracic aperture. The extent of the lesion required not only the removal down to the level of the sternal notch but a safe distance distal to this level. The necessary mobilization following transection of the esophagus in this region might well be at a critical point in its blood supply from the inferior thyroid artery.[18] Therefore, it was decided to extirpate the entire esophagus and re-establish continuity of the alimentary canal by anastomosing the stomach to the pharynx. This plan necessitated the assurance that the stomach in an adult could be safely brought that high.

Fresh cadavers were dissected and measurements made to find the shortest route for the mobilized stomach to follow from the thorax to the pharynx. It was found that, by passing the mobilized stomach directly through an opening in the mediastinal pleura above the aortic arch just posterior to the left sub-

*By Dr. Melvin Thorner.
†By Dr. Rosalind Thorner.

clavian artery at its origin, the stomach was following the shortest possible route to its anastomosis. This placed the stomach in the position of the extirpated cervical esophagus. Sweet[18, 19] has accomplished an esophagogastric anastomosis by passing the mobilized stomach through the apex of the chest into the neck by removal of the medial end of the left clavicle and a portion of the first rib for a tumor in the superior mediastinal segment. This was tried on cadavers but it was found that in requiring the stomach to go to the level of the cricoid cartilage a more direct route to that point was obtained by immediately passing the stomach into the posterior mediastinal space above the aortic arch posterior to the subclavian artery. Obtaining sufficient mobilization of the stomach was not a factor for, in mobilizing the stomach for carcinoma of the thoracic esophagus at or just above the aortic arch after the manner of Garlock[14] and Sweet,[15, 16] we occasionally obtained more stomach than was necessary. This could be assured if the duodenum were sufficiently mobilized to bring the pylorus to the point of closure of the diaphragm.[14, 15, 16]

Fig. 1.—The approach to the cervical esophagus is made along the medial border of the left sternocleidomastoid muscle.

The operative technique is shown in Figs. 1, 2, 3, 4, 5, 6, 7, and 8. On May 5, 1948, anesthesia was induced and endotracheal tube installed. Incision was then made along the medial border of the left sternomastoid muscle (Fig. 1). The sternomastoid muscle and carotid sheath were retracted laterally and the left lobe of the thyroid was visualized as were the left inferior thyroid artery and the recurrent laryngeal nerve. The artery was doubly ligated and transected between ligatures close to the gland. The thyroid gland and the trachea were then slightly elevated and retracted to the patient's right so that the

cervical esophagus could be visualized. It was completely mobilized from the cricoid cartilage down to the thoracic inlet (Fig. 2). The tumor mass, which started just below the level of the cricoid, extended downward for approximately a little over three-quarters of the distance of the cervical esophagus. There were no nodes whatsoever to be palpated in the neck. The esophagus with the tumor was dissected out smoothly so that it was felt that the patient was operable. The wound in the neck was then closed with skin sutures. The saphenous vein in the medial malleolus in one leg was exposed and a size 15 cannula was installed. No. 17 cannulated needle was then placed in the other ankle vein; transfusion

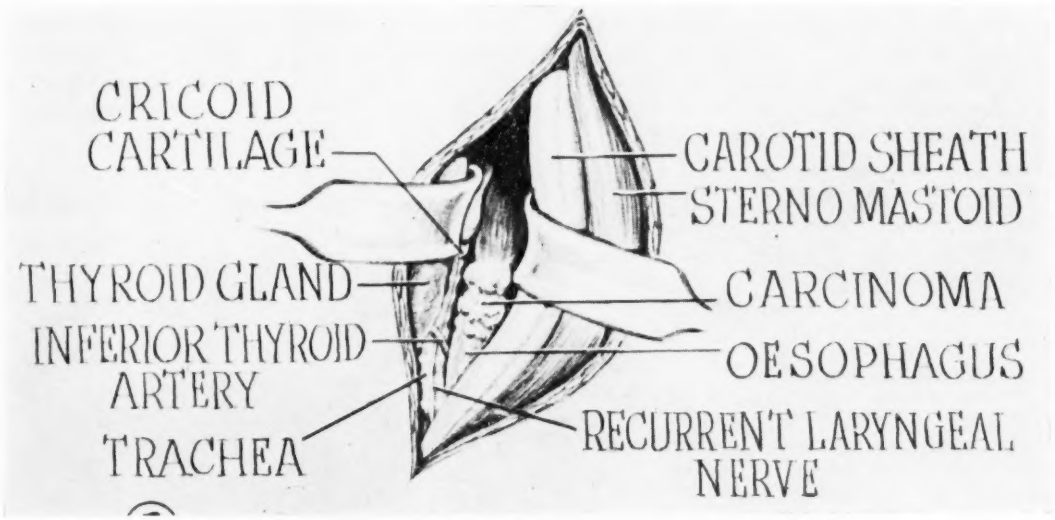

Fig. 2.—It is essential to perform first the dissection shown here in order to determine operability.

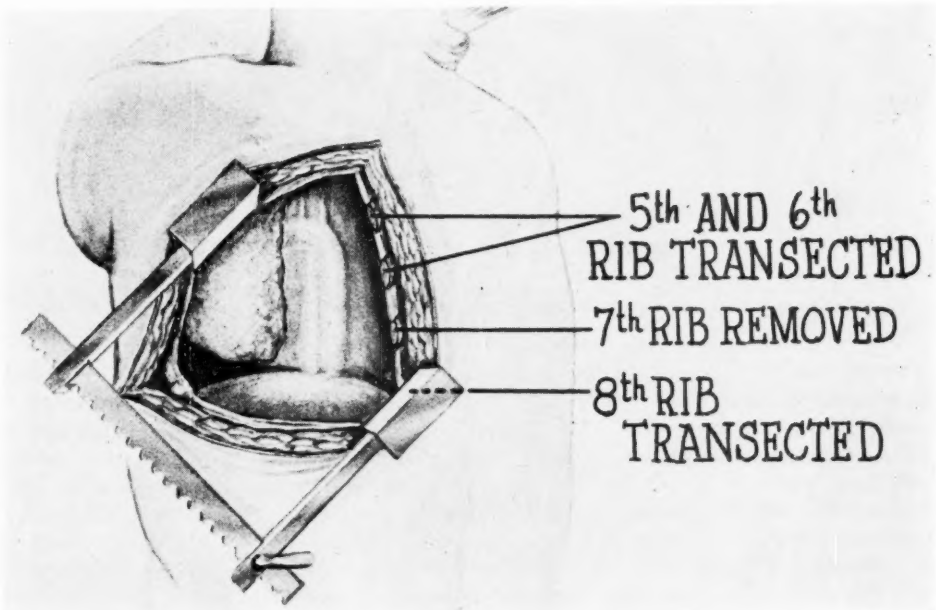

Fig. 3.—The patient is lying on the right side; the inferior end of the incision is extended to the anterior axillary line.

was started and the patient was turned with the left side up. Left posterolateral thoracotomy was then done with the removal of the left seventh rib from a point proximal to its angle to within 1 cm. of its chondral junction. A 1 cm. section of the eighth rib and of the sixth and fifth were then removed posterior to their angles (Fig. 3). The phrenic nerve was crushed just above the diaphragm. The pulmonary ligament was opened and the esophagus mobilized in this region and carried down to its junction with the stomach. The diaphragm was then incised from the esophagogastric junction out laterally to its thoracic attachments. The stomach was then mobilized in the following fashion: The left gastric artery was ligated and transected close to its origin from the celiac axis. Next the vasa brevia and the left gastroepiploic arteries were ligated and transected. The gastrohepatic ligament was then incised and the greater omentum was taken off its attachment to the greater curvature. This was carried over to the duodenum. Care was taken to see that the epiploic vessels along the greater curvature and the arterial arch along the lesser curvature were not endangered.

Fig. 4.—The diaphragm has been opened, the stomach mobilized, and the esophagus separated from the stomach and mobilized above and below the aorta and up into the base of the neck.

The spleen was constantly in the field and it was removed. The peritoneal reflection over the first and second part of the duodenum was then released and it was possible to bring the stomach up into the chest to a point where the pyloric vein was approximately where the normal esophagogastric junction had been. The esophagus was then mobilized up to the arch of the aorta and under the arch. The vagus and recurrent laryngeal nerves were visualized and carefully avoided. The mediastinal pleura above the arch and posterior to the left subclavian artery was opened and the esophagus mobilized in this region. The thoracic duct was not visualized. Approximately one-inch from the stomach the esophagus was transected between two catgut ties. The upper end was covered by thumb of a rubber glove so that no soiling would occur. The lower end was inverted into the stomach and oversewn with two layers of interrupted cotton. Dissection was then directed to the upper end of the esophagus to a point where the area of previous mobilization in the neck was reached from below (Fig. 4). The sutures were then removed from the wound in the neck, the esophagus again readily

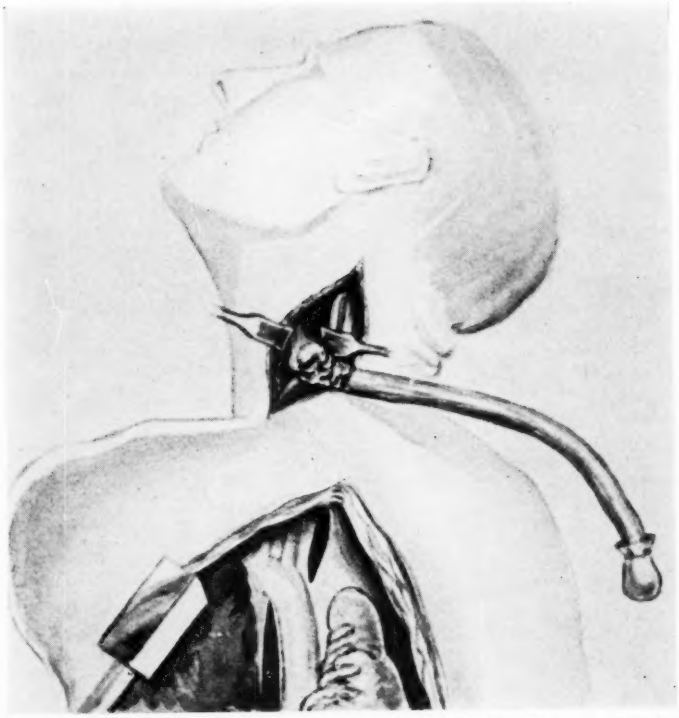

Fig. 5.—The esophagus has been completely mobilized by this combined approach.

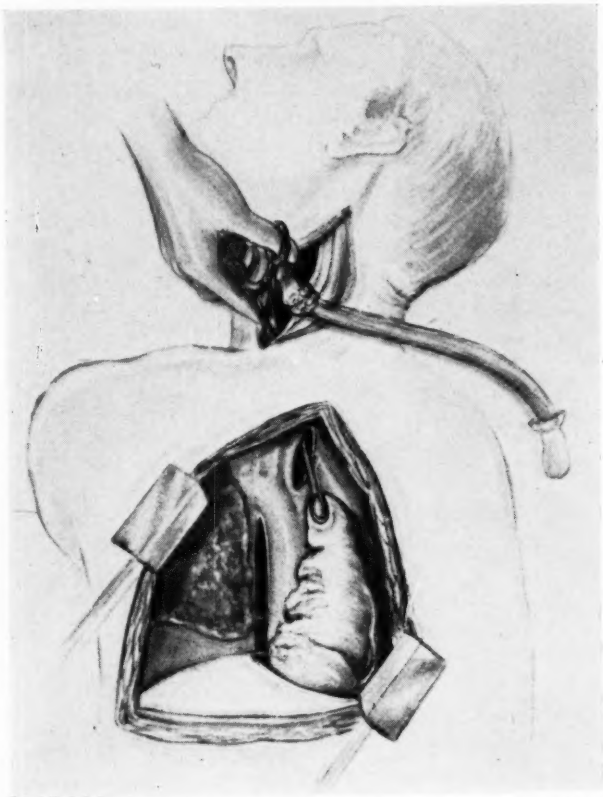

Fig. 6.—A sponge forceps is passed from the cervical exposure down into the chest and the highest point of the stomach grasped preliminary to guiding it into the neck.

Fig. 7.—The stomach is sutured to the mediastinal pleura above and below the aortic arch and the diaphragm is closed about its pyloric end. The umbilicating protrusion caused by the inversion of the distal end of the esophagus is depicted at the point where the stomach passes into the posterior mediastinum.

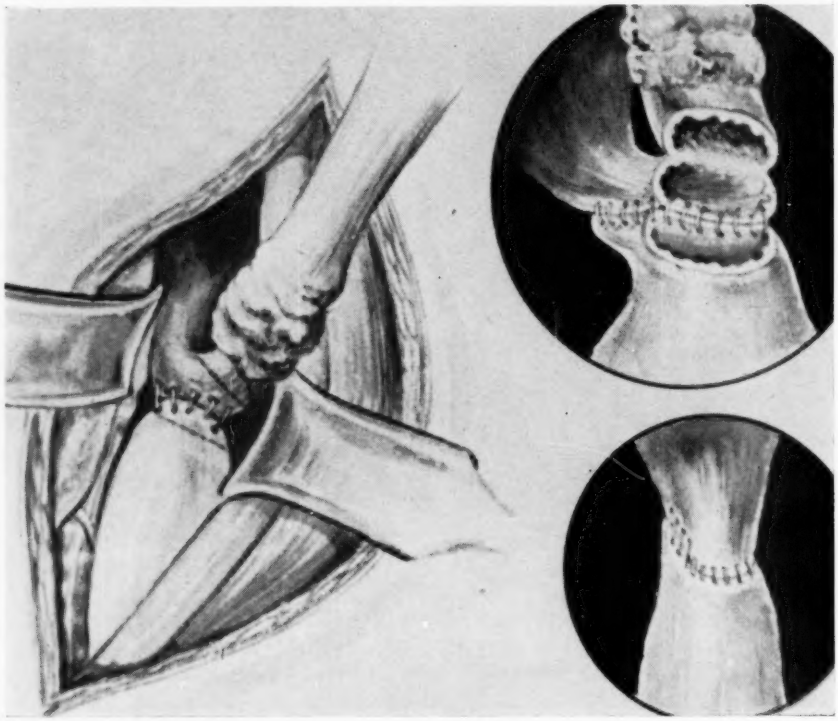

Fig. 8.—The pharyngogastrostomy is performed as depicted here. Posteriorly, two rows of sutures are possible, but anteriorly only one row could be used.

exposed, and the esophagus pulled out of the neck (Fig. 5). A sponge forceps was then passed down from the cervical exposure through the opening in the mediastinal pleura above the arch of the aorta (Fig. 6). The stomach was then placed in the apex of the chest and that point of the cardia which could be estimated as the highest was grasped by the sponge forceps and pulled into the neck. It reached far enough that it was felt that anastomosis between the

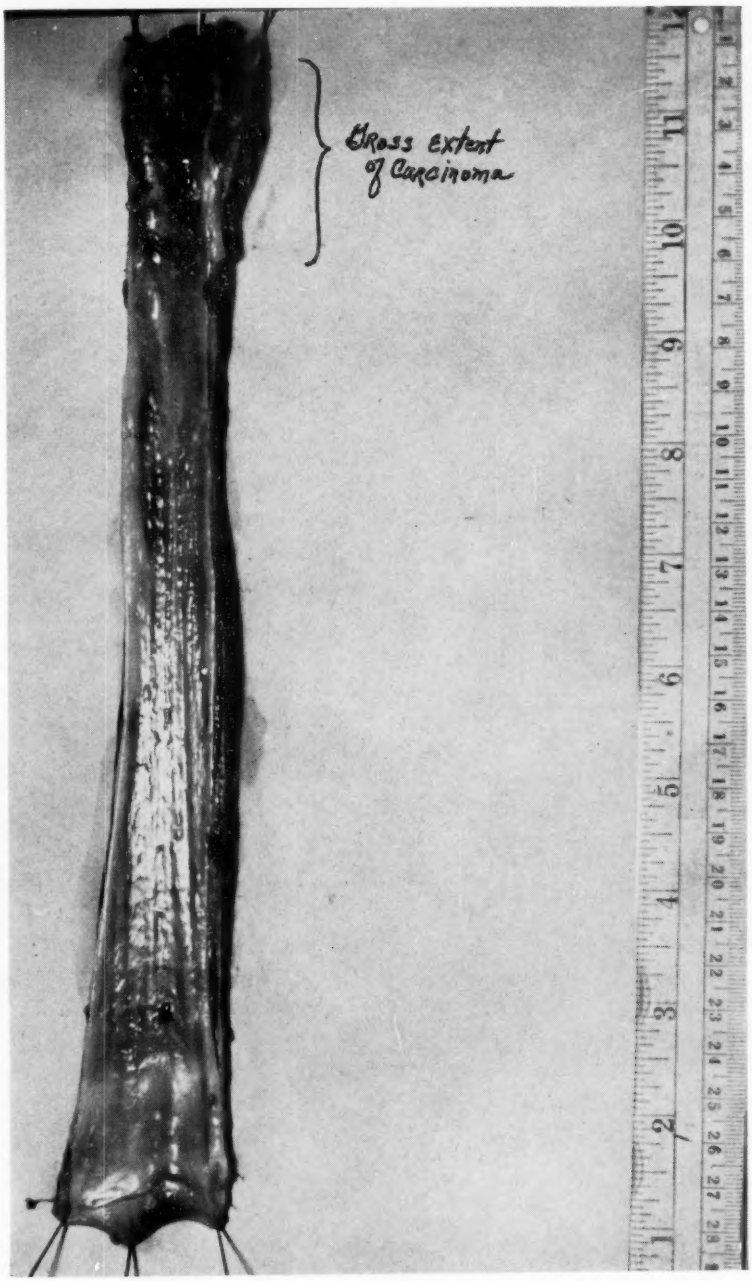

Fig. 9.—Photograph of the surgical specimen. Approximately 2½ cm. at its lower end were turned into the stomach and 1½ cm. of its upper end were removed for microscopic sectioning.

converging fibers of the inferior constrictor muscle and the stomach could be done without too much tension. The stomach was then sutured to the parietal pleura all along and parallel to the descending aorta. It was also sutured to the free edge of the opening in the mediastinal pleura above the aortic arch. The diaphragm was then closed around the stomach by interrupted cotton (Fig. 7). The pleural cavity was washed out and the lung completely expanded by the anesthetist. Previous to closure of the chest, two intercostal tubes were placed into the left side of the chest, one in the eighth intercostal space in the midaxillary line, and the second intercostal tube in the second intercostal space in the midclavicular line. The ends of the tubes inside the chest were tied in place loosely with catgut. The tubes were placed on Davidson suction bottles as the chest was being closed. The patient was then turned

Fig. 10.—Photograph taken at autopsy. The anterolateral portion of the left chest has been removed. The medial end of the left clavicle has been mobilized and is being held out of the field. The left subclavian artery has been removed. The level of the anastomosis is pointed out by the scissors in the upper portion of the photograph.

on his back and anastomosis was carried out as depicted in Fig. 8 with removal of the entire esophagus (Fig. 9). A Levine tube was passed through the nose into the pharynx through the anastomosis and into the stomach during the anastomosis. A drain was placed alongside the anastomosis down into the mediastinum and the wound was closed loosely around it. Bronchoscopy was performed immediately and roentgenogram was taken on the table which showed a completely expanded lung. The patient left the operating table in good condition, having received 2,000 c.c. of blood during the operation.

The patient's postoperative course was uneventful until the sixth postoperative day, when death suddenly occurred while the patient was sleeping.

Fig. 11.—Photograph taken at autopsy to show detail of the pharyngogastrostomy. The hypopharynx was transected and turned in a caudad direction. The anastomosis is pointed out by the tissue forceps.

Essential autopsy findings were as follows. Cause of death was a massive pulmonary embolism arising from the right iliac veins. The anastomosis in the cervical region was intact (Fig. 10). The details of the anastomosis can be seen in Fig. 11. Microscopic sections revealed an engorgement of veins in the upper portion of the stomach with extravasation of blood elements into the muscular layer. Search for cervical lymph nodes revealed a few very soft and small which contained no carcinoma. Microscopic section of the proximal end

of the removed esophagus revealed no carcinoma. Microscopic section of the posterior aspect of the esophagus at the level of the carcinoma revealed the carcinoma had not perforated its muscular layer.

DISCUSSION

Certain points are worthy of note:

1. It is of interest that, although the patient's symptoms were present for two years (the lesion was probably present longer), the carcinoma was limited to the esophagus, there being no evidence of involvement of any lymph node.

2. In accord with our previous experience, the actual gross extent of the lesion is almost always greater than expected by roentgenographic studies and to a less extent more extensive than noted by esophagoscopic examination. Only the lower edge of the lesion gave evidence of a filling defect by barium studies. The junction of the esophagus and the pharynx is, of course, difficult to study.

3. Many authors have pointed out that the mildness and obscurity of symptoms and the reluctance to esophagoscope all degrees of dysphagia render many diagnoses late. In this case, it remained for a neuropsychiatrist to suggest the diagnosis after the patient had been seen by numerous physicians. We feel that the use of sodium pentothal as described is an ingenious method to determine functional elements.

4. It is, of course, imperative that the cervical dissection be done first. Should nodal involvement be found the operation would then be staged so that the first stage would be a radical nodal dissection as done by Bricker and coworkers.[13] The dissection of nodes in the superior mediastinum would then of necessity be a part of the later total removal of the esophagus.

5. The thoracic approach as used was satisfactory. For dissecting above the aortic arch through a transthoracic posterolateral approach, the technical considerations as lucidly discussed by DeBakey and Ochsner[20] should be carefully studied.

6. The stomach can be brought to the inferior portion of the hypopharynx and anastomosed. It was observed that during the anastomosis in the cervical region when the stomach was pulled up to the level of the cricoid cartilage the arteries were still functioning and pulsating well, but the veins appeared distended and quite bluish. This improved by the time the anastomosis was done. It is believed that this partial venous obstruction was due to the fact that the sizable mass resulting from turning in the last inch of the esophagus into the stomach was exactly at the level of the opening in the mediastinal pleura above the aortic arch, and this probably caused some pressure (Fig. 7). Therefore, in repeating this operation, the esophagus should be removed entirely from the stomach for we believe that this will remove any possibility of pressure by a thickened portion of the stomach as it passes through into the neck.

SUMMARY

The literature concerning treatment of carcinoma of the cervical esophagus has been reviewed and a case is presented of carcinoma of the cervical esophagus treated by one-stage total esophagectomy and pharyngogastrostomy. Certain technical considerations are illustrated and discussed.

REFERENCES

1. Czerny: Neue Operationen, Zentralbl. f. Chir. 4: 433-434, 1877.
2. Mikulicz, J.: Ein Fall von Resection des Carcinomatosen Esophagus mit Plastischem Ersatz des excidirten Stuckes, Prag. med. Wchnschr. 11: 93, 1886.
3. Von Hacker, V.: Ueber Resection und Plastik am Halsabschmidtt der Speiserohre Insbesondere beim Carcinoma, Verhandl. d. deutsch. Gesellsch. f. Chir., Berl. 37: 359-425, 1908.
4. Lane, W. A.: Excision of a Cancerous Segment of the Esophagus: Restoration of the Esophagus by Means of Skin Flap, Brit. M. J. 1: 16, 1911.
5. Eggers, C.: Carcinoma of the Upper Esophagus and Pharynx, Ann. Surg. 81: 695, 1925.
6. Torek, F.: Carcinoma of Larynx, Pharynx, Trachea and Esophagus, Ann. Surg. 84: 889, 1926.
7. Evans, Arthur, quoted by Turner: Recent Advances in the Treatment of Carcinoma of the Esophagus from the Surgical and Radiological Aspects, Proc. Roy. Soc. Med. (Sect. Laryngol.) 27: 7-17, 1934.
8. Trotter, quoted by Pilcher, R.: Carcinoma of the Cervical Esophagus, Lancet, p. 73, 1937.
9. Watson, William L.: Cancer of the Cervical Esophagus, Ann. Surg. 116: 86-96, 1942.
10. Nielsen, Jens: Klinische Versuche zur Strahlenbehandlung des Speiseröhrenkrebses, Acta. radiol. 21: 352-367, 1940.
11. Wookey, Harold: The Surgical Treatment of Carcinoma of the Pharynx and Upper Oesophagus, Surg., Gynec. & Obst. 75: 499-506, 1942.
12. Wookey, Harold: The Surgical Treatment of Carcinoma of the Hypopharynx and the Oesophagus (Hunterian Lecture delivered at the Royal College of Surgeons of England, Sept. 30, 1947), Brit. J. Surg. 35: 249-266, 1948.
13. Bricker, Eugene, Burford, Thomas H., and Eisman, Ben: Use of Tubed Pedicle Grafts in Carcinoma of the Upper Esophagus. Read at the Meeting of the American Association for Thoracic Surgery, June 1, 1948, Quebec, Canada. (In press.)
14. Garlock, John H.: Surgical Treatment of Carcinoma of the Oesophagus, Arch. Surg. 41: 1184-1208, 1940.
15. Sweet, Richard H.: Carcinoma of the Midthoracic Oesophagus; Its Treatment by Radical Resection and High Intrathoracic Oesophagogastric Anastomosis, Ann. Surg. 124: 653-666, 1946.
16. Sweet, Richard H.: Subtotal Esophagectomy With High Intrathoracic Esophagogastric Anastomosis in the Treatment of Extensive Cicatricial Obliteration of the Esophagus, Surg., Gynec. & Obst. 83: 417-427, 1946.
17. Watson, William L., and Pool, John L.: Cancer of the Cervical Esophagus. A Discussion of Treatment, SURGERY 23: 893-905, 1948.
18. Sweet, Richard H.: The Treatment of Carcinoma of the Esophagus and Cardiac End of the Stomach by Surgical Extirpation. 203 Cases of Resection, SURGERY 23: 952-975, 1948.
19. Sweet, Richard H.: Carcinoma of the Superior Mediastinal Segment of the Esophagus; a Technic for Resection With Restoration of the Continuity of the Alimentary Canal, SURGERY 24: 929-938, 1948.
20. DeBakey, Michael E., and Ochsner, Alton: Subtotal Esophagectomy and Esophagogastrostomy for High Intrathoracic Esophageal Lesion, SURGERY 23: 935-951, 1948.

INTRATHORACIC GASTROENTERIC CYSTS

HUGH LINDER, M.D., BIRMINGHAM, ALA.

GASTROENTERIC cysts appearing within the chest are rare but are amenable to treatment if properly recognized and appropriately treated. Davis and Salkin[1] stated that up to July, 1946, twenty-five cases had been reported and they added one case. Except for the case reported by Dixon and co-workers[2] in October, 1946, and known to Davis and Salkin, I have been able to find only two additional cases, thus making a total of twenty-eight cases. The first case was reported in 1909 by Staehelin-Burkhardt.[3] Because of this infrequency of reported cases it is thought that the present report is justified.

CASE REPORT

N. J. K., aged 4 years, was admitted to the Children's Hospital Sept. 21, 1945, on the Pediatric Service, with the diagnosis of chronic empyema, and was referred to me. The child was born full term of healthy tenant farmer parents and is the sixth of nine children. The other children were normal, all living and well. The patient weighed 7½ pounds at birth and development progressed normally except for the illness herein described. She had had pertussis and mumps. She had been bottle-fed but was taking a usual diet supplemented with vitamins at the time of admission to the hospital.

At the age of 3 months she had whooping cough which was complicated by pneumonia and otitis media. She improved under sulfonamide therapy. Two weeks later she began having attacks of dyspnea and cyanosis. At this time temperature was 102° to 103° F. She was found to have fluid in the chest, and about one pint of straw-colored fluid was removed at weekly intervals. This aspiration was repeated eight to ten times and a tube was inserted between the ribs. In February, 1942, a rib resection was done and a larger tube inserted which remained for about one year. During this year she developed normally except that she continued to be underweight. Drainage continued periodically until admission and became increasingly profuse during the preceding two weeks. On a number of occasions she had hemoptysis and shortly after the original rib resection had several severe hemoptyses. There was also bleeding from the cavity. Repeated transfusions were required.

Physical examination revealed a pale undernourished female child in no acute distress. During the few days after admission the rectal temperature reached a maximum of 101° F. Admission weight was 35 pounds. The right ear was draining foul, purulent material. Tonsils were moderately enlarged. Teeth were dirty and carious. There was a draining sinus just below the tip of the right scapula. The discharge was serosanguineous and had a foul odor. The surrounding skin was red and edematous and a red, papular rash was present over much of the back. Breath sounds were poorly heard on the right. No râles were heard. The entire right thorax was dull on percussion. Heart sounds were normal and there was no marked displacement. Abdomen, genitals, and extremities were normal. No clubbing of the digits was noted.

Admission red blood cell count was 3,650,000. Hemoglobin was 60 per cent. White blood cell count was 21,000 with 32 per cent lymphocytes and 68 per cent polymorphonuclear cells. The urine was negative. X-ray studies of the chest showed the heart shadow and left lung to be normal except for some shift of the heart to the left. On the right side there was a synostosis between the eighth and ninth ribs with a fenestration through the eighth rib. The right lung was partially collapsed. No calcification was noted in the region of the sinus and cavity (Fig. 1).

Biopsy of the sinus tract showed only nonspecific granulation tissue.

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The child was put on forced feeding with vitamin supplements and was given repeated blood transfusions. She improved markedly and gained weight. The drainage continued to be profuse, was sanguinopurulent and very irritating to the adjacent skin. Various ointments were used as a protective dressing but were ineffective. On Oct. 13, 1945, portions of three ribs overlying the cavity were resected, the sinus tract was excised, and the cavity itself unroofed for adequate drainage. It was realized at this time that this was not a simple empyema cavity and the possible diagnosis of bronchiogenic cyst was considered. After administration of adequate amounts of blood the condition was satisfactory.

The wound healed gradually over a period of weeks and although the discharge from the cavity continued to be profuse and irritating, the child continued to improve. Lipiodol injection at this time revealed a bilobed cavity 11 by 4½ cm. in its greatest dimensions located in the posterolateral aspect of the chest cavity and extending from the diaphragm to the fifth rib (Fig. 2).

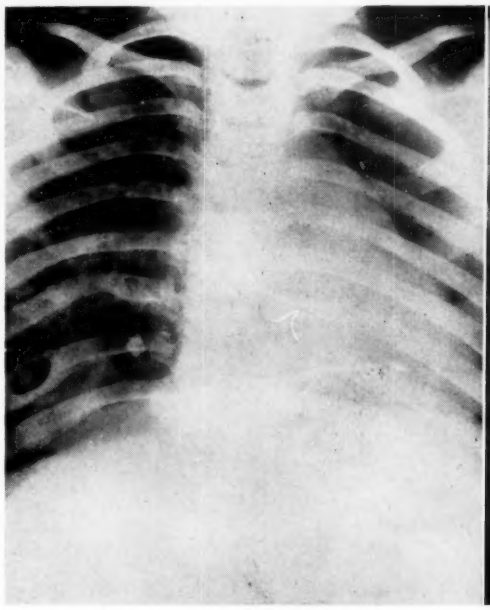

Fig. 1.

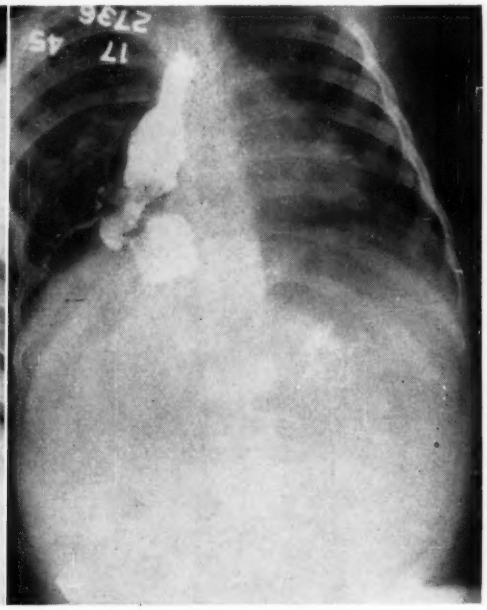

Fig. 2.

Fig. 1.—Plain film of chest before operation.
Fig. 2.—Lipiodol injection of cavity before operation.

On Jan. 4, 1946, a second operation was undertaken with the intention of surgically excising the lining of the cavity. Open drop ether anesthesia was used. The old incision was opened and platelike, regenerated bone excised. The lining of the cavity was noted to be about 1 mm. in thickness, velvety and grayish pink in color. The adjacent lung was approximately normal and the visceral pleura was thin. The cavity consisted of an upper and lower locule, the lower one extending to the diaphragm. Removal of the cyst was begun and it was found that it could be fairly easily peeled away from the lung, diaphragm, and posterior chest wall. There was moderate hemorrhage and the anesthetic was poorly taken. It was decided to remove only the lower locule of the cyst at this time. The wound was packed loosely with gauze, partially closed, and the operation terminated.

Recovery after this procedure was rapid. The wound healed quickly and the discharge decreased greatly.

The final operation was done March 8, 1946, at which time the superior locule was removed in a manner similar to the preceding operation. The cyst wall separated easily and

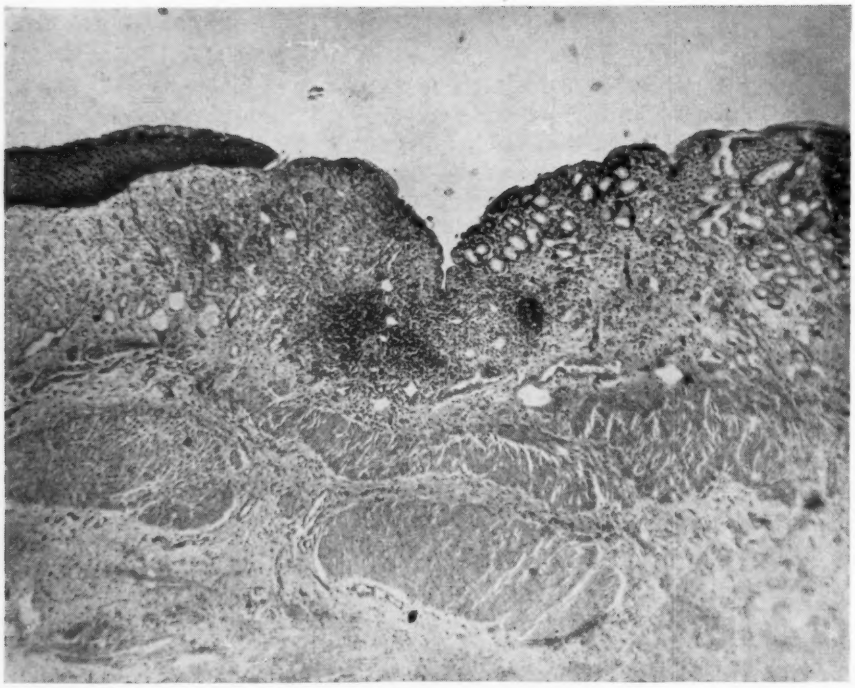

Fig. 3.—Photomicrograph of section taken from cyst wall showing esophageal and gastric mucosa (low power).

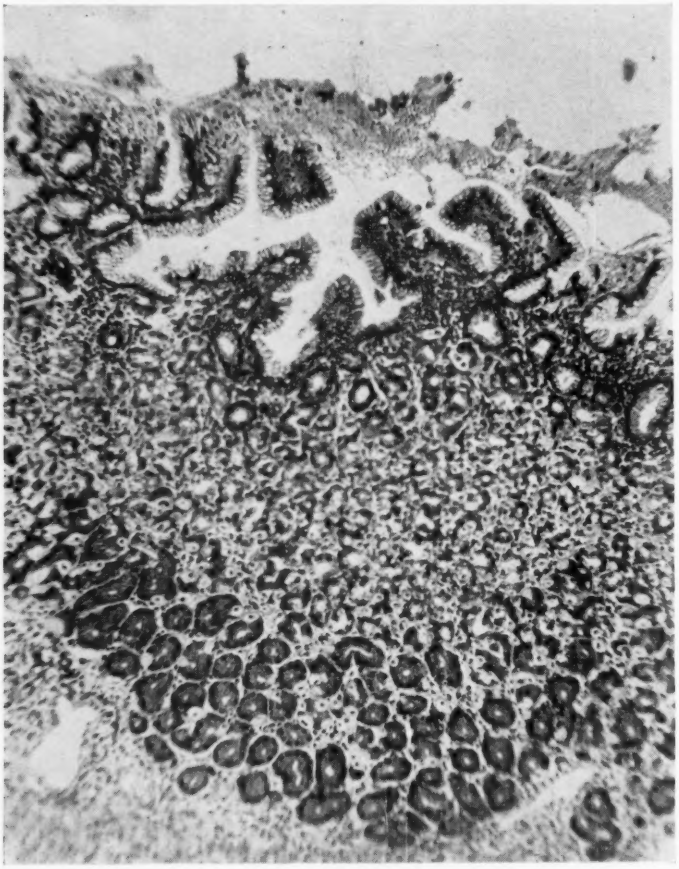

Fig. 4.—Section showing gastric mucosa (high power).

there was no communication with the lung or bronchus at any point. A narrow fibrous attachment extended from the apex of the cyst to the region of the lateral wall of the esophagus, but there was no demonstrable communication. After excision of the cyst the tissues were allowed to fall together, the wound was loosely packed with gauze, and partially closed. This procedure was well borne and the patient suffered less shock than on the previous occasions.

The pathologic report* of the cyst wall was as follows:

Gross Description: The specimen consisted of an irregular mass, 3.5 by 5.5 by 3.8 cm. It was 0.7 cm. thick, and was apparently slightly edematous and reddened. It was composed of fibrillar tissue, some of which appeared to be interlaced with muscle.

Microscopic Examination: Section through the specimen showed at one end of it a lining of stratified squamous epithelium. Beneath this epithelium there was some loose edematous connective tissue which was richly vascular and infiltrated with lymphocytes. Below this there was a muscularis mucosa consisting of longitudinal smooth muscle bundles. Between these muscle bundles there was a group of circular muscle bundles and some mucus-secreting glands lined by columnar epithelium. Down the section typical gastric mucosa was encountered, with some portions of the glands lined by columnar epithelium—and this epithelium was acidophilic. There was also one large focal collection of lymphocytes just beneath the mucosa.

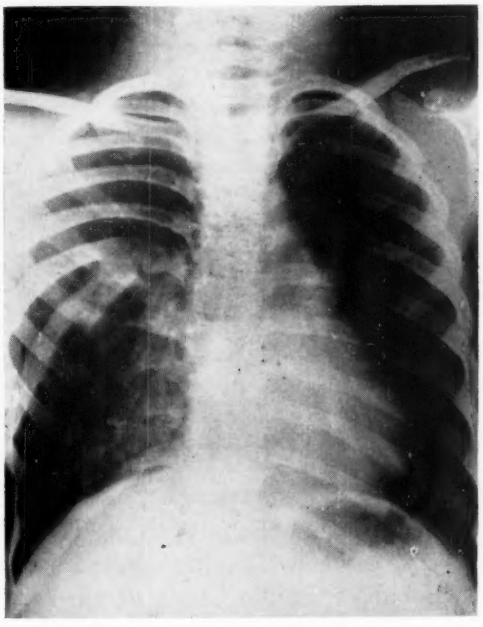

Fig. 5.—Roentgenogram of chest, May, 1948.

Diagnosis: Gastric cyst (Figs. 3 and 4).

The wound filled in satisfactory but a small shallow sinus, 1 inch deep, persisted until the patient's discharge from the hospital on Aug. 4, 1946. It has, however, now been healed for more than a year. She is apparently entirely well, goes to school regularly, and has no symptoms referable to the chest. Weight is 50 pounds and height 48 inches. Nutrition is good and she shows no evidence of chronic disease. Posture is good and there is no notable scoliosis. Recent chest x-ray examination was negative except for the deformity resulting from rib resection (Fig. 5). Bronchogram showed no abnormalities. X-ray views of the spine showed no abnormal curvature. Chest expansion is about equal on the two sides.

*By Dr. J. A. Cunningham.

Comment.—In the case reported here the symptoms of dyspnea and cyanosis occurring at the age of 3 months with the mistaken diagnosis of pneumonia and empyema are usual. Aspiration yielded fluid which, no doubt, would have suggested the diagnosis of gastric cyst had it been examined. The extreme excoriation of the skin about the fistula would indicate peptic activity. The history of massive hemoptysis suggests that ulceration may have been present at one time but was not evident at the time of operation. The long period elapsing between the original drainage of the cyst and its removal is probably unique. The ease with which the cyst could be excised was notable and the lack of communication with the esophagus was fortunate. The final result is quite satisfactory as shown by complete healing, excellent development, and lack of crippling.

DISCUSSION

Intrathoracic gastroenteric cysts are a part of a large group of mediastinal cysts classified by Laipply[4] as follows:

I. Congenital
   1. Epidermoid
   2. Dermoid
   3. Teratoma
   4. Pericardial coelomic cyst
   5. Bronchial cyst
   6. Oesophageal cyst
   7. Gastro-enteric cyst
      (a) Gastric
      (b) Enteric
   8. Cystic lymphangioma

II. Acquired
   1. Parasitic cyst
   2. Neoplastic cyst
   3. Cystic hematoma

Gross Characteristics.—The cysts may be present in either side of the chest but are said to be more common on the right side. There is no sex predilection. They vary greatly in size and may fill the hemithorax, thus producing severe pressure symptoms. Being congenital, most of them manifest themselves in infancy, although a case occurring in a 23-year-old man is reported by Schwarz and Williams[5] and it is possible this inactive type may even go undiscovered. The cysts may be entirely unattached to the adjacent portion of the alimentary canal or there may be extensive attachment and communication. Communications with the bronchus are reported and may be due to peptic ulceration or may result from early embryologic maldevelopment. They may be unilocular or multilocular and may extend through the diaphragm. There may be multiple, entirely separate cysts within the thorax sometimes associated with intra-abdominal enterogenous cysts. It is noteworthy that no reports of associated Meckel's diverticulum are reported, a matter of interest in relation to the embryologic aspects. The cysts may contain esophageal, gastric, or intestinal

remnants in various combinations but the gastric type predominates. The gastric cysts reported have shown peptic activity in approximately two-thirds of the cases and ulceration has occurred in several.

Embryology.—Several theories have been offered in explanation of the origin of these cysts. The origin from intrathoracic vestiges of the vitelline duct similar to origin of intra-abdominal intestinal variations has been suggested by Fitz.[6] It is to be remembered that the thoracic and abdominal cavities are not differentiated at this stage. It is noteworthy that no cases of enterogenous cysts of the chest occurring with Meckel's diverticulum have been reported. Lewis and Thyng[7] have explained the origin of such cysts from "knoblike outpocketing of intestinal epithelium" from the primitive foregut. This theory could also explain the origin of bronchiogenic cysts and gastroenteric cysts which contain ciliated epithelium. The presence of ciliated epithelium may also occur as a result of persistence of the embryologic esophageal epithelium. Keith[8] has explained their origin from a failure of transverse coalescence of vacuoles during the resolution of the solid stage of the alimentary tube. In this manner cysts may result which are completely separate from, or intimately attached to, the adjacent alimentary tract.

Clinical Features.—The essential clinical manifestations are those of an actively secreting mediastinal lesion. In those cysts that show peptic activity the symptoms develop rapidly and may be complicated by peptic ulceration, often into a bronchus. The typical case is one in which symptoms appear in the first few weeks or months of life and consist of dyspnea, cyanosis, cough, and usually evidences of pulmonary infection. Hemoptysis of more or less severity is common. Hematemesis also may occur. Both are usually indicative of ulceration. Most cases have been thought to have recurring attacks of pneumonia followed by empyema and the diagnosis has become evident only after aspiration of fluid. The fluid reaccumulates rapidly in the active cases and the peptic activity and acidity can be easily demonstrated. The inactive cysts may be discovered only by x-ray examination and may not be differentiated from other mediastinal tumors except by operation.

Physical examination will disclose evidences of acute or chronic intrathoracic disease often with mediastinal displacement. Signs suggesting pneumonia and pleural fluid are often present.

X-ray examination will reveal changes characteristic of posterior mediastinal tumor unless the hemithorax is so filled as to obscure the origin. In such instances the picture simulating loculated pleural effusion is seen. If the fluid is removed and lipiodol injected, the cyst can be well shown. The roentgenogram may also reveal mediastinal displacement and esophageal angulation. The ribs and vertebrae may be eroded as shown by the case of Mixter and Clifford.[9] Bronchograms may reveal a connection between bronchus and cyst. There may also be a demonstrable connection between esophagus and cyst.

Diagnosis of intrathoracic gastric cyst must therefore rest on the demonstration of an intrathoracic cystic tumor from which fluid showing acid and peptic activity is obtained.

Treatment.—Treatment of this lesion is surgical extirpation. In the occasional, accidentally discovered or relatively inactive case one-stage removal would be ideal. In most instances the diagnosis is not known and the child is in a precarious condition, pneumonia and empyema often being the diagnosis. In such instances the suggestion of Ladd and Scott[10] that the cyst be marsupialized and removed at a later date seems wise. The use of sclerosing substances for destruction of the mucosa has been suggested. It would appear wiser to excise surgically the cyst wall wherever possible and apply escharotics and curettage only when the cyst cannot be surgically excised.

Davis and Salkin[1] stated that surgery was performed in seventeen of twenty-six cases reported and was successful in ten. The remaining nine cases were discovered at autopsy.

SUMMARY

A case of intrathoracic gastric cyst is reported with comments from the literature on the subject. The long interval between original symptoms and definitive treatment is unusual. The success of multiple stage treatment is again demonstrated.

REFERENCES

1. Davis, Edgar W., and Salkin, David: Intrathoracic Gastric Cysts, J. A. M. A. **135:** 218-221, 1947.
2. Dixon, J. A., Clagett, O. T., and McDonald, John R.: Intrathoracic Gastric Cyst, J. Thoracic Surg. **15:** 318-323, 1946.
3. Staehelin-Burkhardt, A.: Ueber eine mit magenschlemimhaut versehene Cyste des Osaphagus, Arch. f. Verdauungskr. **15:** 584-603, 1909.
4. Laipply, T. C.: Cysts and Cystic Tumors of the Mediastinum, Arch. Path. **39:** 153-161, 1945.
5. Schwarz, H., and Williams, C. S.: Thoracic Gastric Cysts, J. Thoracic Surg. **12:** 117-130, 1943.
6. Fitz, R. H.: Persistent Omphalo-mesenteric Remains: Their Importance in the Causation of Intestinal Duplication, Cyst-formation, and Obstruction, Am. J. M. Sc. **88:** 30, 1884.
7. Lewis, F. T., and Thyng, F. W.: The Regular Occurrence of Intestinal Diverticulae in Embryos of the Pig, Rabbit and Man, Am. J. Anat. **7:** 505, 1908.
8. Keith, Arthur: Quoted by Ladd and Scott, Human Embryology and Morphology, Baltimore, Md., 1933, William Wood & Company.
9. Mixter, C. G., and Clifford, S. H.: Congenital Mediastinal Cysts of Gastrogenic and Bronchogenic Origin, Ann. Surg. **90:** 714-729, 1929.
10. Ladd, W. E., and Scott, H. W.: Oesophageal Duplications or Mediastinal Cysts of Enteric Origin, SURGERY **16:** 815-835, 1944.

FATE OF CARDIAC FOREIGN BODIES

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AMONG the many problems to receive renewed interest as a result of World War II was that of the fate of metallic foreign bodies in and about the heart, and the advisability of their removal. During the interval between the first and second World Wars, thoracic surgery had advanced to the point where, technically, it was quite feasible to explore the pleural or pericardial cavities and, indeed, to operate upon the heart itself. Until the advent of the war there were few reported cases of the successful removal of retained cardiac foreign bodies. It is only natural that thoracic surgeons, meeting this problem for the first time in military hospitals and without the background of established procedure, should, therefore, solve it according to their individual daring and ingenuity. Moreover, the number of such cases was fortunately small, and thus a single surgeon's experience was limited.

The majority of American, British, and German surgeons favored removal of the foreign body for prophylactic purposes, whether or not the patient was having signs or symptoms of cardiac disfunction. Beck,[1] Edwards,[2] and Sauerbruch[3] lend the weight of their reputation to this view.

Harken,[4, 5, 6, 7] in describing the removal of 55 pericardial and 13 intracardiac missiles, stated that more foreign bodies, presumably within the heart, were allowed to remain unoperated than were removed. However, he advanced the following four points as justification for surgical intervention as a prophylactic measure.

(1) Prevention of embolism of the foreign body or an associated thrombus.
(2) Reduction of danger of bacterial endocarditis.
(3) Prevention of recurrent pericardial effusions.
(4) Diminution of the incidence of myocardial damage.

According to Schaefer and Satinsky[8] the dangers of permitting a foreign body to remain in the musculature of the heart is threefold:

(1) Cardiac rupture, especially the rupture of a cardiac aneurysm.
(2) Migration into the adjacent cavity with embolism formation or interference with capacity of function of the chamber.
(3) Injury to a coronary vessel.

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It is true that these complications have a definite theoretical basis, and scattered examples of their occurrence can be gleaned from the literature. The majority of reported cases, however, do not present such sequelae.

Indeed, that these projectiles often may be permitted to remain undisturbed without endangering the life of the patient has been reported by a number of writers.[1, 10] The most extensive case reports have come from Russian literature. Four separate surgeons[11, 12, 13, 14] reported a total of 128 cases which did not show any serious clinical or subjective findings during the period observed. It is true that the period of observation was only four to eight months in the majority of instances, but a significant number were followed from one to fifty-two years after the initial wound. In the English literature, Bland[15] reported eight cases of metallic foreign body in and about the heart which were not removed and in which the patient had only minimal subject symptoms during the four to seven months observed.

From these and other reports[16, 17, 18] it would appear that most cases of retained foreign bodies in and about the heart, excluding those obviously in need of immediate surgery to stop hemorrhage and cardiac tamponade, etc., may be grouped in three categories.

A small group had no signs of symptoms whatsoever, the foreign body being picked up on routine x-ray examination, usually at the time of discharge from service. Another small group had definite signs of impaired cardiac function. The majority, however, presented minimal to mild subjective symptoms without objective signs of any real cardiac disfunction.

It is to be stressed, however, that observation after return to normal routine and work is necessary to evaluate these patients. Not infrequently with increased load on the heart, symptoms such as mild precordial pain, tachycardia, and extrasystole become manifest. Many of the investigators mentioned reported this to be especially true of cases in which the foreign body lies in the pericardial sac.

Another point which is repeatedly stressed is the profound psychologic effect upon the patient of the knowledge of a retained foreign body embedded in the heart combined with minimal symptoms. Not infrequently these patients are anxious to accept a serious surgical risk to gain peace of mind.

Without precedent of established routine, the surgeon's decision to intervene may be swayed by such a psychologic factor. On the other hand if the surgeon could be sure in his own mind that there was little likelihood of serious sequelae, he would be in a much better position to reassure the patient.

In addition, as pointed out by Harken,[19] one must be cautious in evaluating straight statistical studies of reported cases. In his series one-half the patients referred to the thoracic center as having foreign bodies "in the heart" were found not to have these missiles in the heart when careful fluoroscopic examination was done. Furthermore, one-third of the missiles previously considered to be intracardiac were not found in the heart at surgical exploration.

An experimental study was undertaken to determine the fate of metallic foreign bodies introduced in and about the heart. By the study of such experi-

mental lesions, in conjunction with statistical analyses of clinical cases, it was hoped that more definite indications and contraindications for surgical intervention might be postulated.

METHODS

The experiment was carried out using young dogs weighing 6 to 15 kilograms. The foreign bodies were irregularly shaped fragments of metal, cast iron or brass for the most part, 3 to 10 mm. in diameter and weighing 0.15 to 5.0 Gm. A definite attempt was made to simulate bomb or granade fragments. In addition, actual 0.30 caliber rifle slugs were used in a few cases. Using intratracheal, positive pressure ether anesthesia, the dog's chest was opened aseptically and the fragments were introduced into the pericardia sac, into the right and left myocardium, and also directly into the right and left auricular and ventricular cavities. The animals were x-rayed or fluoroscoped as soon as the chest was closed and at frequent intervals during the period of observation. In some animals with foreign bodies in the pericardium and myocardium electrocardiographic studies were done before, during, and at intervals up to three months following operation. All animals were re-operated upon or sacrificed at regular intervals up to twelve weeks after operation. In every case autopsies were performed and sections made for pathologic study.

PERICARDIUM

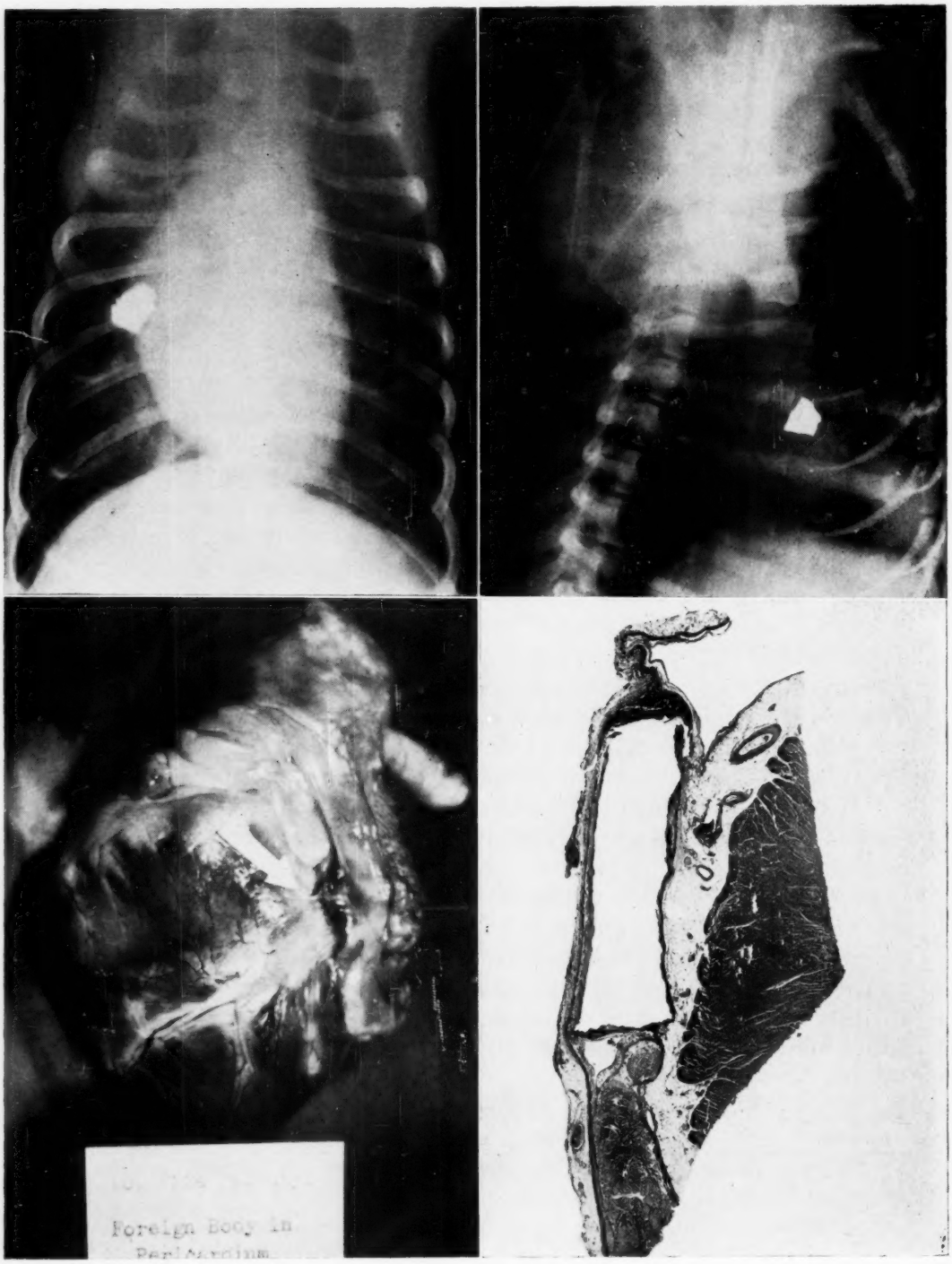
A total of eight dogs were studied (see Table I). The foreign bodies were introduced into the pericardial sac through a small incision in the pericardium. This incision was then closed by a continuous silk suture. Except Dog 308 which died within two days from a bronchopleural fistula and tension pneumothorax, all the dogs were alive and clinically well at the time they were sacrificed.

It is to be noted in Dog 308 that after two days one of two foreign bodies placed in its pericardial sac was already adherent to the tip of the left auricular appendage. The other lay free, but there was no effusion or evidence of damage to heart muscle itself or to the coronaries. In Dog 600 the foreign body was still free at the end of two weeks. In this case alone was there evidence of superficial trauma to the epicardium. There were numerous abrasions over the surface of the heart, but there was no damage to a coronary and no effusion. In the remaining six dogs sacrificed from two to twelve weeks, the foreign bodies were all well encapsulated.

TABLE I. PERICARDIUM

DOG NO.	INTERVAL		FINDINGS
308	2 days	died of bronchopleural fistula	1. Slightly adherent 2. Free in pericardium
600	2 weeks	sacrificed	1. Free in pericardium 2. Superficial abrasions
636	2 weeks	sacrificed	Loosely encapsulated
304	4 weeks	sacrificed	Well encapsulated
171	6 weeks	sacrificed	Well encapsulated
224	8 weeks	sacrificed	Densely encapsulated
214	12 weeks	sacrificed	Well encapsulated
597	12 weeks	sacrificed	Densely encapsulated

A. B.

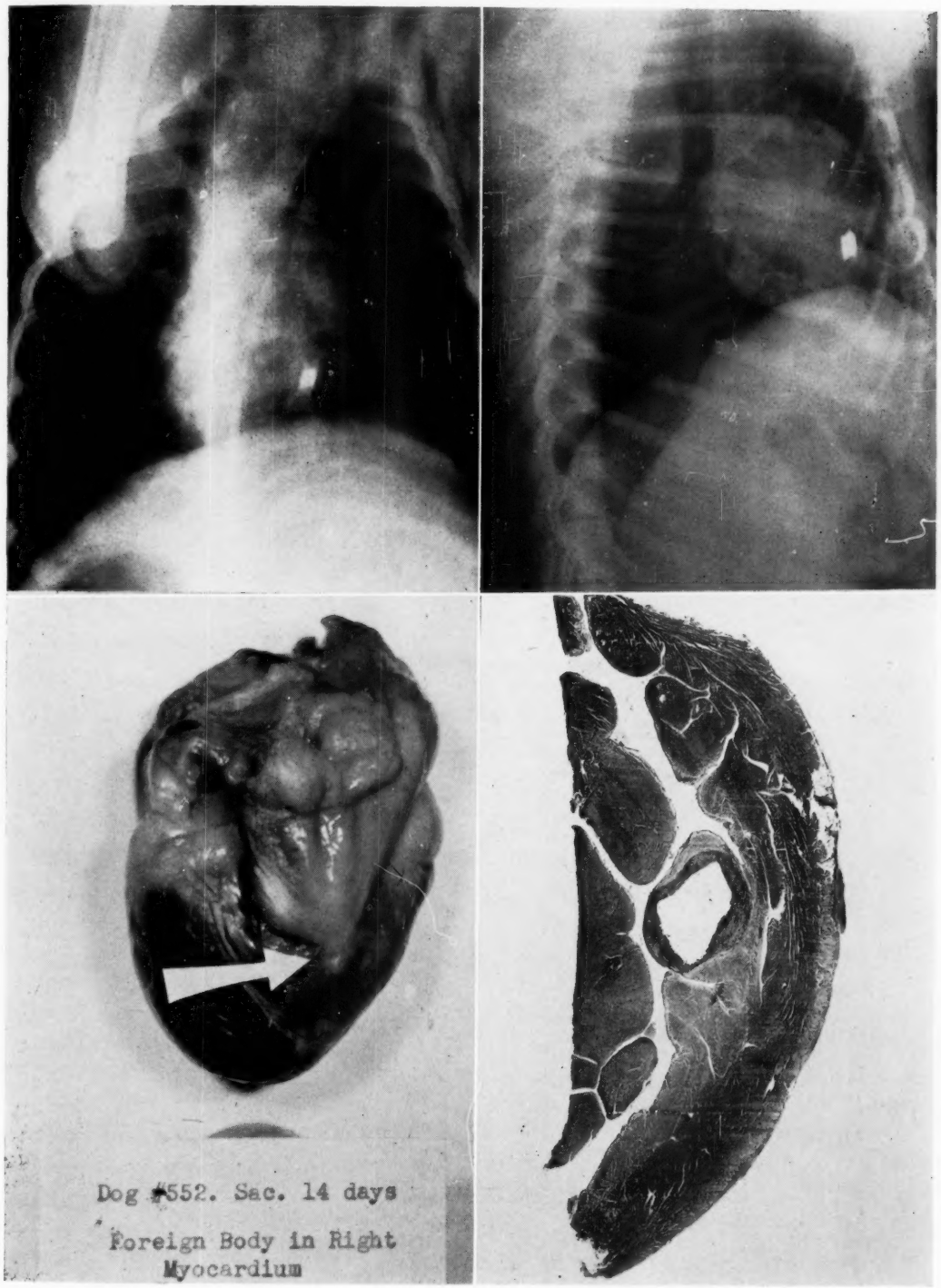


C. D.

Fig. 1 (Dog 224).—Foreign body in pericardium, sacrificed at eight weeks. *A* and *B*, Anteroposterior and lateral x-ray views taken shortly prior to autopsy. Note relative size of foreign body, normal size and contour of heart, and absence of effusion. *C*, Autopsy specimen. Note local encapsulation of foreign body and smooth glistening epicardium. *D*, Low-power photomicrograph. Note the thin fibrous capsule surrounding the foreign body, the relatively normal pericardial and epicardial surfaces away from the foreign body, and the absence of any underlying myocardia reaction.

A.

B.



C.

D.

Fig. 2 (Dog 552).—Foreign body in right myocardium, sacrificed at two weeks. *A* and *B*, anteroposterior and lateral x-ray views taken shortly prior to autopsy. Note normal size and contour of heart and relative size of foreign body. *C*, Autopsy specimen. Note local pericardial adhesions. *D*, Low-power photomicrograph. Note narrow zone of fibrous reaction about foreign body, normal surrounding myocardium and no endocardial reaction. This foreign body actually lay within the base of a papillary muscle.

The foreign body was usually located near the base of the heart and although there were dense local adhesions in the region of the foreign body, the remainder of the cavity was, in most cases, free of adhesions. There was no evidence of a general fibrous reaction such as might be the precursor of a constrictive pericarditis. There were no pericardial effusions noted. There were no changes whatsoever in the electrocardiograms.

MYOCARDIUM

In eighteen dogs metallic foreign bodies were placed in the wall of a ventricle, six being placed in the right myocardium and twelve in the left myocardium. This was accomplished by opening the pericardial sac widely displacing the heart from the sac and steadying it by means of a traction suture in its apex. Various sites were selected, care being taken, however, to avoid injuring a coronary vessel. A stab wound was then made in the myocardium and a tunnel fashioned to receive the foreign body. Bleeding was controlled by means of a silk suture, or in a few cases by gelatin sponge.

Of the six dogs with foreign bodies in the right myocardium (see Table II), all were alive and well when sacrificed two weeks to seven months later. Dog 726 was reoperated upon at 2½ weeks and the foreign body was removed successfully. Grossly there appeared to be minimal reaction about the foreign body.

TABLE II. RIGHT MYOCARDIUM

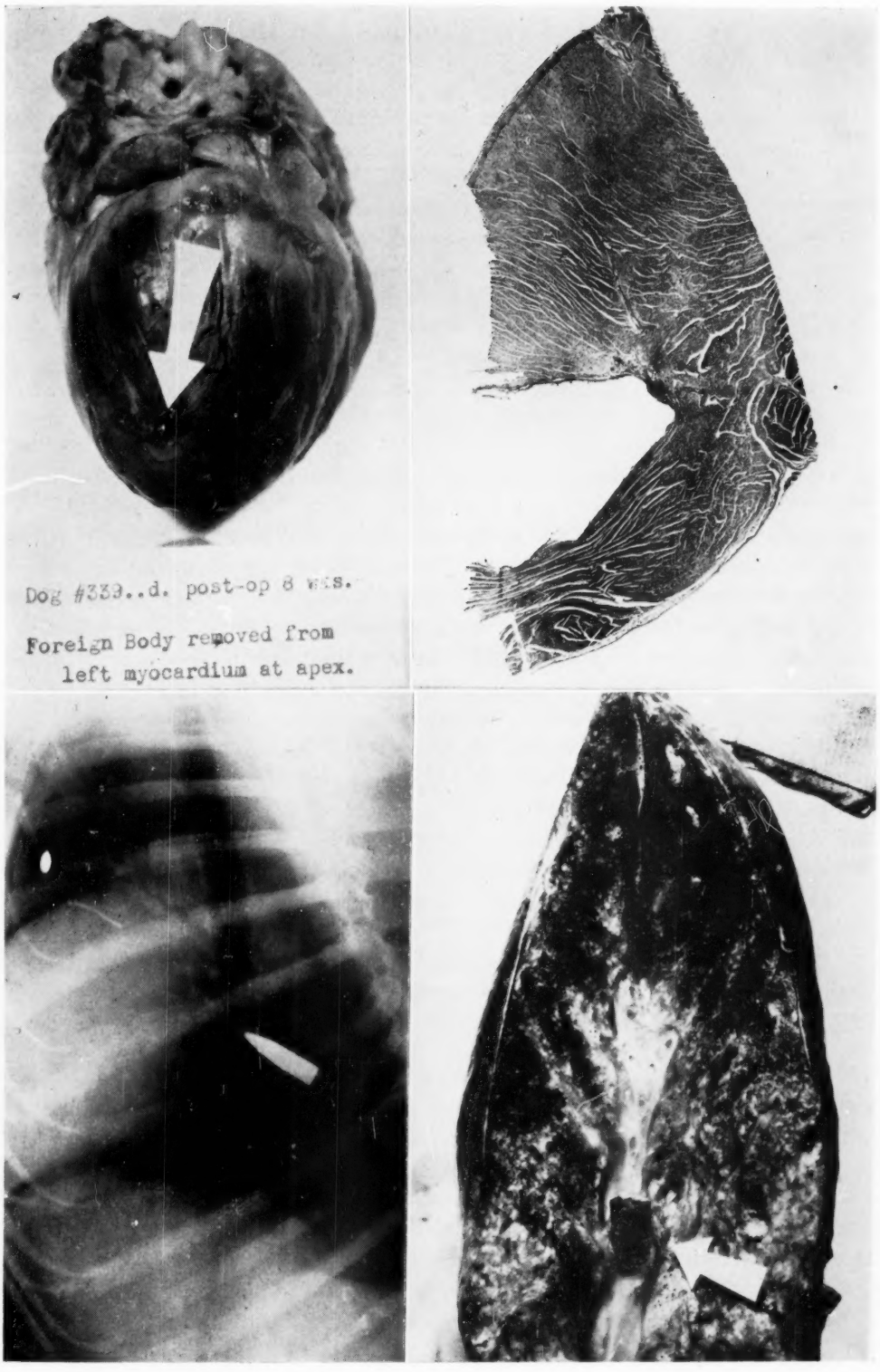
DOG NO.	INTERVAL		FINDINGS
552	2 weeks	sacrificed	Moderate inflamatory reaction
726	2½ weeks	removed	Minimal reaction
293	4 weeks	sacrificed	Early fibrous encapsulation
426	8 weeks	sacrificed	Firmly embedded in fibrous scar
297	12 weeks	sacrificed	Firmly embedded in fibrous scar
733	7 mo.	sacrificed	Firmly embedded in fibrous scar

At autopsy none of the dogs showed pericardial effusions. There were only moderate fibrous adhesions in the region of the wound in the myocardium. Early there was microscopic evidence of a nonspecific inflammatory reaction in the myocardium about the foreign body as evidenced by accumulations of round cells. There was an early proliferation of fibrous tissue but by eight weeks the foreign body was firmly embedded in a fibrous tissue scar which measured out 1 to 3 mm. in thickness. The surrounding myocardium did not appear damaged and there was no evidence of a cardiac aneurysm.

Of the fourteen dogs with foreign body in the left myocardium (see Table III), two died as a result of surgery, the remaining twelve being alive and clinically well at the time of reoperation or sacrifice one to twelve weeks later.

Dog 489 died of distemper at four days. There was an extensive infarction of the myocardium in the area of the wound. The foreign body lay free in the pericardium together with about 50 c.c. of bloody fluid. The wound had been made rather high on the ventricular wall and apparently a coronary vessel had been injured. It is felt that had this dog survived its distemper, perhaps the infarction might have led to a cardiac aneurysm.

A. B.



C. D.

Fig. 3.—*A*, Dog 339. Foreign body removed from left myocardium at eight weeks. Autopsy specimen. *B*, Dog 200. Foreign body in left myocardium, sacrificed at eight weeks. Low-power photomicrograph. Note the thin fibrous capsule and minimal reaction of surrounding myocardium. *C*, Dog 128. Foreign body in right ventricle with embolism to pulmonary artery. X-ray picture at six weeks. Note size of foreign body and absence of infarct of lung. *D*, Dog 114. Foreign body in right ventricle with embolism to pulmonary artery. Sacrificed at one week. Autopsy specimen. Note size and location of foreign body, and infarct of left lower lobe.

TABLE III. LEFT MYOCARDIUM

DOG NO.	INTERVAL		FINDINGS
489	4 days	died—pneumonia	Extensive infarction, foreign body free in pericardium
678	1 week	sacrificed	Moderate inflammatory reaction
488	2 weeks	sacrificed	Mild inflammatory and fibrous reaction
503	2 weeks	removed	Minimal reaction
264	3 weeks	died, infection	Purulent pericarditis and myocarditis
350	4 weeks	sacrificed	Early fibrous encapsulation
310	4 weeks	removed	Firmly embedded
171	6 weeks	sacrificed	Firm fibrous capsule
200	8 weeks	sacrificed	Firm fibrous capsule
339	8 weeks	removed	Firmly embedded
332	12 weeks	sacrificed	Firm fibrous capsule
298	12 weeks	removed	Firmly embedded

Dog 264 died at three weeks of a purulent pericarditis and myocarditis and empyema. The foreign body had sloughed out of the myocardium into the pericardial sac which contained about 100 c.c. of frank pus. It is believed that the infection resulted from faulty sterilization of the foreign body.

In four instances the dogs were reoperated upon at two, four, eight, and twelve weeks and the foreign body was removed successfully. It was found that the dense adhesions of the pericardium in the region of the wound in the myocardium were of definite aid in locating the foreign body. Early the foreign body was only lightly encapsulated but by eight weeks it was firmly embedded in the myocardium and it was with difficulty that it was extracted. It was felt that considerable additional trauma to the myocardium occurred during this forceful procedure.

At autopsy the findings in the remaining dogs were similar to those with foreign body in the right myocardium.

PULMONARY CIRCUIT

In fifteen dogs foreign bodies were placed directly into the right ventricular chamber (see Table IV). This was accomplished by ligating the azygos vein and then placing traction ligatures about the superior and inferior venae cavae.

TABLE IV. PULMONARY CIRCUIT

DOG NO.	INTERVAL		LOCATION OF FOREIGN BODY	
A	1 day	sacrificed	RLL	no infarct
132	2 days	died, pneumonia	RLL	no infarct
193	2 days	died, pneumonia	LLL	no infarct
114	7 days	sacrificed	LLL	infarct
925	10 days	sacrificed	LLL	infarct
920	10 days	sacrificed	Chamber of ventricle	
926	2 weeks	sacrificed	RLL	no infarct
597	3 weeks	died	RUL	no infarct
768	4 weeks	died	RLL	no infarct
48	5 weeks	sacrificed	LLL	no infarct
310	7 weeks	sacrificed	LLL	infarct
651	8 weeks	sacrificed	RML	no infarct
503	12 weeks	sacrificed	LLL	no infarct
927	12 weeks	sacrificed	Rt. auricular appendage	
128	8 weeks	removed	RLL	fibrosis & hyperemia

The pericardial sac was then opened. After placing a mattress suture in the wall of the right ventricle the venae cavae were occluded. In about thirty seconds the right ventricle was seen to empty. A stab would was then made in the wall of the ventricle between the mattress sutures and the foreign body introduced into the chamber with minimal blood loss. The mattress suture was tied to close the defect and the venae cavae were released. The pericardium was then closed with silk sutures and the chest closed.

In all but two instances the foreign body had embolized to the lung at the time the operation was terminated and the dog could be fluoroscoped.

In Dog 920 the foreign body remained in the chamber of the ventricle. Apparently it had been caught behind the papillary muscles. When the dog was sacrificed at ten days, because of a severe chest wall infection, there had been no evidence of cardiac disfunction. The foreign body was fixed and encapsulated by a thin layer of fibrin. There was no propagating thrombus in the ventricle.

In Dog 927 the foreign body had in some way migrated to the tip of the right auricular appendage. This was apparent at the first fluoroscopy. Perhaps during the period of occlusion of blood flow it had been manipulated through the tricuspid valve. When the dog was sacrificed at twelve weeks the foreign body was firmly fixed and encapsulated. There was no associated thrombus.

In all the other dogs the foreign body embolized to the lungs. Usually it was found to be lodged in the primary artery to the more dependent lobe. In only three cases was an infarct of the lung caused by this embolus.

In addition, foreign bodies were introduced into the external jugular veins in seven dogs. In all cases the foreign body embolized to the lungs. In a few cases, however, it remained in the heart as long as thirty-six hours. No infarcts were produced in this manner although three of the dogs received, in addition, artificial pneumothoraces in an attempt to produce an infarct.

In one instance, Dog 198, the embolized foreign body was successfully removed from the primary artery to the right lower lobe at eight weeks.

At autopsy the wounds in the ventricle were healing or had healed completely, leaving only a small area of fibrosis.

SYSTEMIC CIRCUIT

In attempting to place the foreign body in the chamber of the left ventricle, the problem of hemorrhage and air embolism was encountered. If hemorrhage was controlled by occluding the venous return to the heart, the pressure within the chambers fell. If then a stab wound was made into the cavity, air entered, embolized to the coronaries and caused death of the animal by ventricular fibrillation. Although in two cases the foreign body was introduced directly through the wall of the ventricle, in the eleven other dogs, however, the foreign body was introduced into the ventricle through the left auricular appendage (see Table V). This was accomplished by the following technique. After opening the pericardium a purse-string suture was placed at the base of the auricular appendage. An incision was then made at the tip of the appendage and the foreign body introduced through the mitral valve on a hemostat. Bleeding was con-

trolled by traction or the purse-string suture holding the wall of the appendage about the hemostat. The high blood pressure in the left auricle prevented air from entering the circulation. After removal of the hemostat the appendage was ligated at its base and excised.

No attempt was made to flush out the pericarial sac, but any large blood clots were removed. The pericardium was then closed with silk sutures and the chest closed.

In all cases except Dog 838, in which the foreign body was probably held in the ligature about the base of the auricular appendage, the foreign body was immediately embolized to systemic artery. In Dog 819 the foreign body was of such a large size that it completely occluded the thoracic aorta and caused the death of the animal. In Dog 24 the foreign body occluded the superior mesenteric artery with resultant infarction and gangrene of the gut. The dog died at the end of twenty-four hours.

TABLE V. SYSTEMIC CIRCUIT

DOG NO.	INTERVAL		LOCATION OF FOREIGN BODY
905	1 day	died, pneumonia	Bifurcation of aorta
24	1 day	died, infarct	Superior mesenteric artery
26	1 day	died, pneumonia	External iliac artery
819	1 hr.	died	occluded thoracic aorta
131	2 days	removed	Femoral artery
790	4 weeks	sacrificed	Bifurcation of aorta
511	4 weeks	sacrificed	Femoral artery
838	6 weeks	sacrificed	Auricular appendage
102	6 weeks	sacrificed	External iliac artery
171	6 weeks	sacrificed	Bifurcation of aorta
95	12 weeks	sacrificed	Femoral artery
726	12 weeks	sacrificed	Bifurcation of aorta
396	12 weeks	sacrificed	External iliac artery

Usually, however, the foreign body was found located near the bifurcation of the aorta. In several cases pulsations in the femoral artery were absent for a few days, but in none was there any critical impairment in circulation to the leg.

SUMMARY

A total of sixty-two dogs were used, only three of which died as a result of the foreign body, two of these being from embolism and occlusion of a systemic artery and one from infection.

Foreign bodies introduced into the pericardium produced minimal local reaction and were well encapsulated by eight weeks. In animals pain is hard to evaluate. Certainly we cannot on the bases of these experiments explain the pain of similar clinical cases.

Only three out of thirty-five foreign bodies introduced directly into the chambers of the heart remained within the heart. Apparently these had been mechanically caught between chordae. No untoward findings were noted in these three cases.

The remaining thirty-three were quickly embolized to the pulmonic or systemic circulation. Those embolized from the right heart lodged in the pri-

mary pulmonary artery to a more dependent lobe. Only rarely was an infarct produced. Those embolized from the left heart lodged for the most part at the bifurcation of the aorta. The site of their lodgment in the systemic circulation apparently was due to the proportionate size of the foreign body.

Of the eighteen foreign bodies placed in the myocardium, only two caused serious results; one because of infection and one because of concomitant extensive infarction of the myocardium due to injury to the coronary artery at the time of surgery.

The other sixteen caused only minimal local reaction and were firmly encapsulated in a fibrous scar by eight weeks. Indeed, the removal of these foreign bodies from the myocardium was accomplished rather by additional myocardial damage. There were no cases of migration of a foreign body from the myocardium into the chamber of the heart.

CONCLUSIONS

On the basis of these experiments, it seems reasonable to conclude that the majority of foreign bodies retained in or about the heart, so long as they are not producing symptoms or signs of cardiac disfunction, may be permitted to remain undisturbed. We do not feel that it is necessary to remove such foreign bodies for prophylactic purposes.

REFERENCES

1. Beck, C. S.: Surgery of the Heart and Pericardium, in Christopher F.: A Textbook of Surgery, Philadelphia, 1942, W. B. Saunders Company, p. 1015.
2. Edwards, A. T.: Wounds of the Thorax, in Bailey, H.: Surgery of Modern Warfare, Vol. I, ed. 2, Baltimore, 1942, Williams & Wilkins Company, p. 385.
3. Sauerbruch, F.: Gunshot Wounds of Heart and Lungs With Retained Projectile, Deutsche Ztschr. f. Chir. **255**: 152, 1941.
4. Harken, D. E.: Foreign Bodies in, and in Relation to Thoracic Blood Vessels and Heart; Technique for Approaching and Removing Foreign Bodies From Chambers of Heart, Surg., Gynec. & Obst. **83**: 117-125, 1946.
5. Harken, D. E., and Williams, A. C.: Foreign Bodies in, and in Relation to Thoracic Blood Vessels and Heart; Migratory Foreign Bodies Within Blood Vascular System, Am. J. Surg. **72**: 80-90, 1946.
6. Harken, D. E., and Zoll, P. M.: Foreign Bodies in, and in Relation to Thoracic Blood Vessels and Heart; Indications for Removal of Intracardiac Foreign Bodies and Behavior of Heart during Manipulation, Am. Heart J. **32**: 1-19, 1946.
7. Harken, D. E.: Surgical Removal of Foreign Bodies From Heart, SURGERY **21**: 150, 1947.
8. Schaefer, W. B., and Satinsky, V. P.: Removal of Shell Fragment From Left Ventricle of Heart, Arch. Surg. **53**: 13, 1946.
9. Myers, C. C., and Mader, J. W.: Gunshot Wound of the Heart, U. S. Nav. M. Bull. **40**: 950, 1942.
10. Gubergrits, A. Y.: Late Sequels of Certain Heart Wounds With Retained Projectiles, Vrach. delo **25**: 335, 1945.
11. Likhtsier, I. B.: Clinical Aspects of Heart Wounds With Retained Projectile, Khirurgiya **2**: 50, 1945.
12. Gomaleya, A. N.: Heart Wounds With Retained Shell Splinter, Klin. med. **21**: 28, 1943.
13. Gerke, A. A.: Indications for Removal of Foreign Bodies of Heart, Khirurgiya **6**: 47, 1944.
14. Lidskiy, A. T.: Indications and Techniques for Surgical Removal of Projectiles From Heart and Pericardium, Klin. med. **23**: 21, 1945.
15. Bland, C. C.: Foreign Bodies in and About the Heart, Am. Heart J. **27**: 588, 1944.
16. Robertson, R. N.: Penetrating Heart Wound, SURGERY **21**: 597, 1947.
17. Holman, E.: Gunshot Wounds of the Heart, U. S. Nav. M. Bull. **40**: 951, 1942.
18. Shapiro, R.: Intra-Cardiac Foreign Body, Am. Heart J. **30**: 88, 1945.
19. Harken, D. E.: Removal of Foreign Bodies From Pericardium and Heart, J. Thoracic Surg. **16**: 701, 1947.

ANATOMIC OBSERVATIONS ON THE LUMBAR SYMPATHETIC NERVOUS SYSTEM

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LUMBAR sympathectomy is well established as a means of relieving vasoconstrictive influence in peripheral vascular disease.

With improved clinical methods of study and better evaluation of diseases related to the vascular system, sympathectomy has become of frequent occurrence. However, in spite of increased interest in the sympathetic nervous system, little effort has been directed toward a better understanding of its regional anatomy. Usually, when this problem is discussed in its clinical aspects, reference to the anatomy of the sympathetic nervous system is minimal or unjustifiably simplified. We believe that many of the disappointing results following sympathectomy, excluding the proper selection of cases, are due to a misunderstanding of the variables in the anatomy of the lumbar sympathetic chain and not in the procedure per se.

This report will attempt to demonstrate the inconstant characteristics of the lumbar sympathetic chain and also discuss what constitutes an adequate sympathectomy from the anatomic viewpoint.

In most modern texts, the lumbar sympathetic nervous system is usually represented as paralleling chains along the respective anterolateral aspects of the lumbar vertebrae, with each trunk incorporating a ganglion overlying the body of each lumbar vertebra. General discussion of the problem is usually limited to the relationship of this system with the psoas muscle, vena cava, and aorta.

In this study, the lumbar sympathetic chain and its ganglia has impressed us as being the most variable portion of the sympathetic nervous system, and one of the most variable structures in human anatomy. This variation is noted in diverse specimens as well as in paralleling chains in the same specimen. A chain anatomically comparable to its contralateral side was noted rarely.

As early as 1783, Walter, in his *Tabulae Nervosum Thoracis et Abdominis* (see Fig. 1, *a*), demonstrated five lumbar sympathetic ganglia on the right side and three lumbar sympathetic ganglia on the left. His drawings of the right side demonstrate a ganglion on the body of each of the lumbar vertebra; on the left side, the first ganglion that is shown is demonstrated on the body of the second lumbar vertebra. This ganglion is connected to the next lower ganglion, which lies on the body of the third lumbar vertebra, by two separate strands. This latter ganglion, in turn, is connected by two separate communications to the next ganglion, which overlies the intervertebral substance of the fourth and fifth lumbar vertebrae.

Swan (see Fig. 1, *b*), whose careful dissections in 1825 won the first and second collegial anatomic prizes awarded by the Royal College of Surgeons in

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London, indicated that on the right side, the first lumbar sympathetic ganglion is located at the level of the beginning of the second lumbar vertebra; the second ganglion, at the lower part of this same vertebra; the third ganglion, between the third and fourth lumbar vertebrae, and the fourth ganglion, between the fourth and fifth lumbar vertebrae. He stated that on the left side there are but two ganglia, the first ganglion located as on the right, while the second ganglion

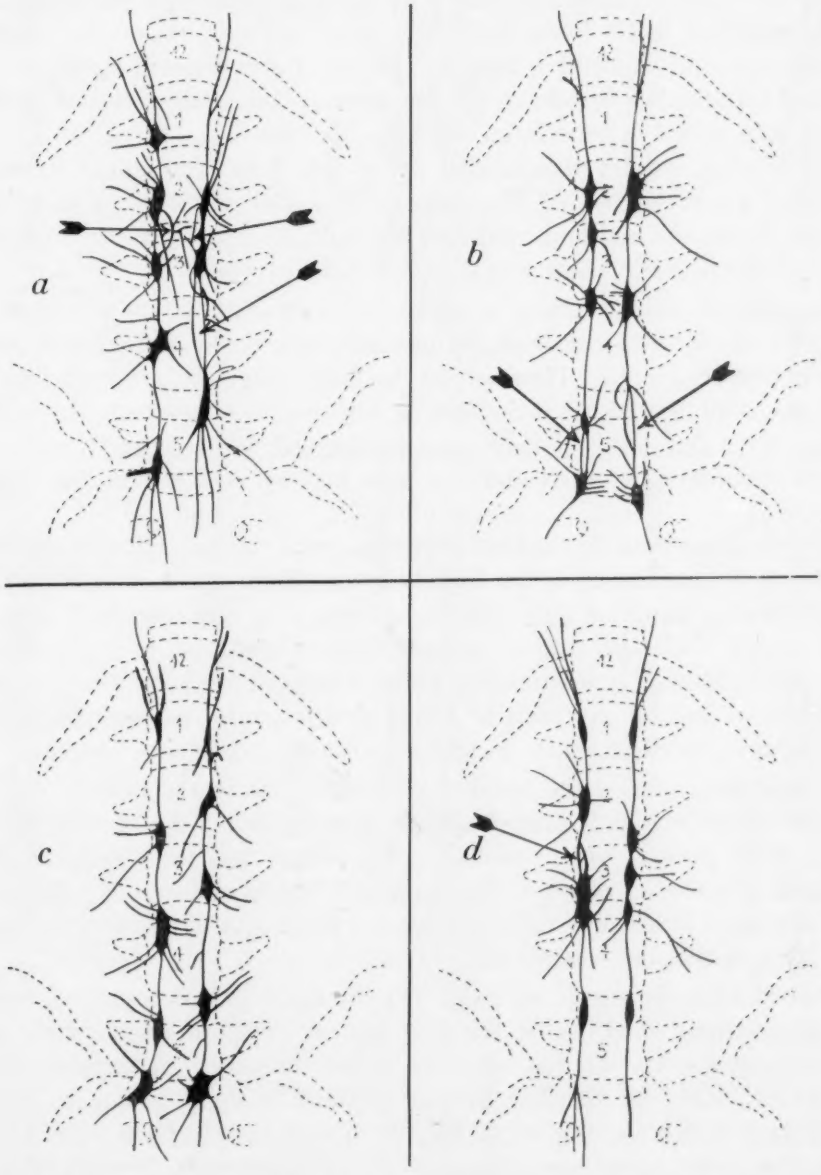

Fig. 1.—*a*, Walter, 1783. Arrows demonstrate by-passing and double communications from one ganglion to another. *b*, Swan, 1825. Double communications are shown by arrows. Note absence of lumbar ganglia on the first lumbar vertebra. *c*, Hirschfield, 1866. Note four paired ganglia on each side. Those on the lower fifth lumbar vertebra are classified as sacral ganglia (see also *b*). It seems that this dissection is that most commonly reproduced for anatomic texts today. *d*, Hovelacque, 1925. Arrow demonstrates double communication.

appears over the upper part of the fourth lumbar vertebra. He considered the two ganglia on the lower aspect of the fifth lumbar vertebra as being sacral.

Hirschfeld (see Fig. 1, *c*), in 1866, showed four ganglia on each respective side, with the fourth ganglion appearing on the upper part of the fifth lumbar vertebra. This work seems to be most often reproduced.

Hovelacque (see Fig. 1, *d*), in 1925, on the right side, placed the first lumbar ganglion on the body of the first lumbar vertebra; the second ganglion, on the middle of the second lumbar vertebra, with three cephalad and one caudad rami; the third ganglion, on the lower half of the third lumbar vertebra and intervertebral substance, and the fourth ganglion, on the intervertebral substance of the fourth and fifth lumbar vertebrae. In his illustrations, he showed four ganglia on the right side, and five ganglia on the left side (see Fig. 1).

In this series, studies were carried out on thirty-six fresh autopsy specimens immediately after removal of the viscera. The abdominal aorta and inferior vena cava were mobilized and retracted medially on their respective sides. The underlying sympathetic chain was then carefully exposed.*

Our original intention was to make approximately 50 to 100 dissections, hoping that the inconsistencies of the lumbar chain could be compiled into two or more composite groups. However, as the work progressed, there seemed to be little or no possibility of the series falling into separate groups.† In preference to presenting a few unusual instances, we decided to demonstrate all autopsy dissections in order that the reader can draw his own conclusions (see Figs. 2 to 7).

After 31 dissections of the lumbar sympathetic region, Atlas concluded that "because of erratic fusion of the lumbar sympathetic tissue it is impossible to designate lumbar ganglion on a numerical basis with any degree of accuracy." He also stated that "because of unpredictable variations in the number and position of the lumbar sympathetic ganglia, it is preferable to describe a lumbar sympathectomy not on the basis of which ganglia were removed, but from the anterolateral surfaces of which vertebral bodies the trunk was resected."

Livingston expressed the opinion that variations in the lumbar region are so common as to render it almost absurd to state that "the second, third and fourth lumbar ganglia were removed." He stated that what is meant is that the surgeon removed as much of the chain as he could conveniently get at, from as near the usual location of the first lumbar ganglion to the point that the chain passed beneath the iliac vessels into the pelvis.

These statements concur with our own studies. In our series, we could not find a sympathetic ganglion on the first lumbar vertebra on the right side in thirteen instances, and on the left side in ten instances. A ganglion was not found on either side of the first lumbar vertebra in eight instances. In every case, the mediolumbocostal arch of the diaphragm had to be sectioned near its lumbar attachment to expose adequately the ganglion when present on the first

*The sympathetic chains were sketched in situ by our artist, Miss Nancy Furneyhough, whose presence at the autopsies made the drawings possible.

†Fourteen additional studies have been made on classroom cadavers and have served to confirm our previous findings.

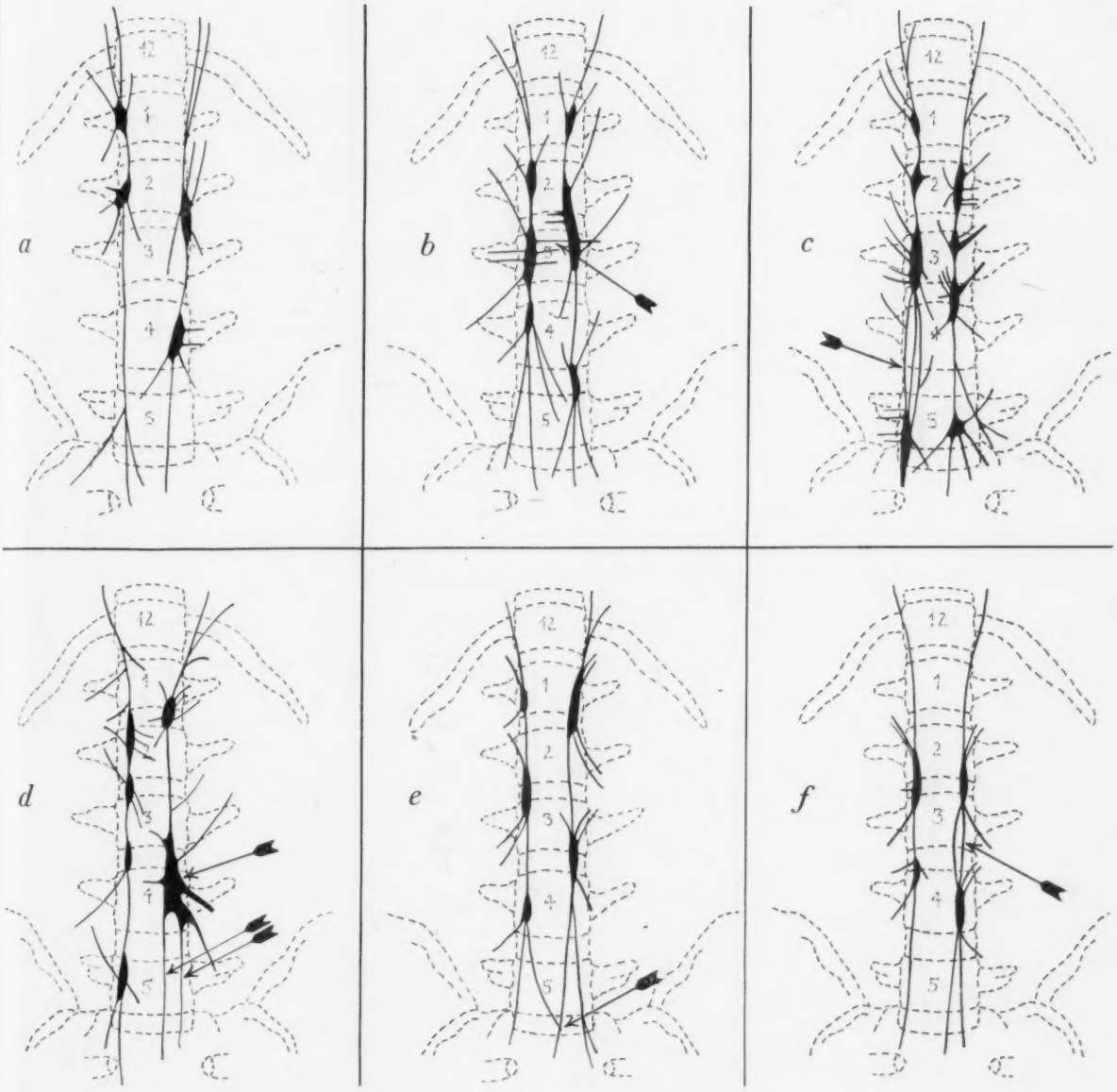

Fig. 2.—*a*, Note the long strand on the right side, extending from the third to fifth lumbar without ganglia. *b*, Arrow showing cross communication. *c*, Arrow showing one ganglion connected to its lower fellow by three separate strands. *d*, Arrows showing huge fused ganglia and double strands parallel to each other. *e*, Arrow showing communication to sacral plexus. *f*, Arrow showing a double communication.

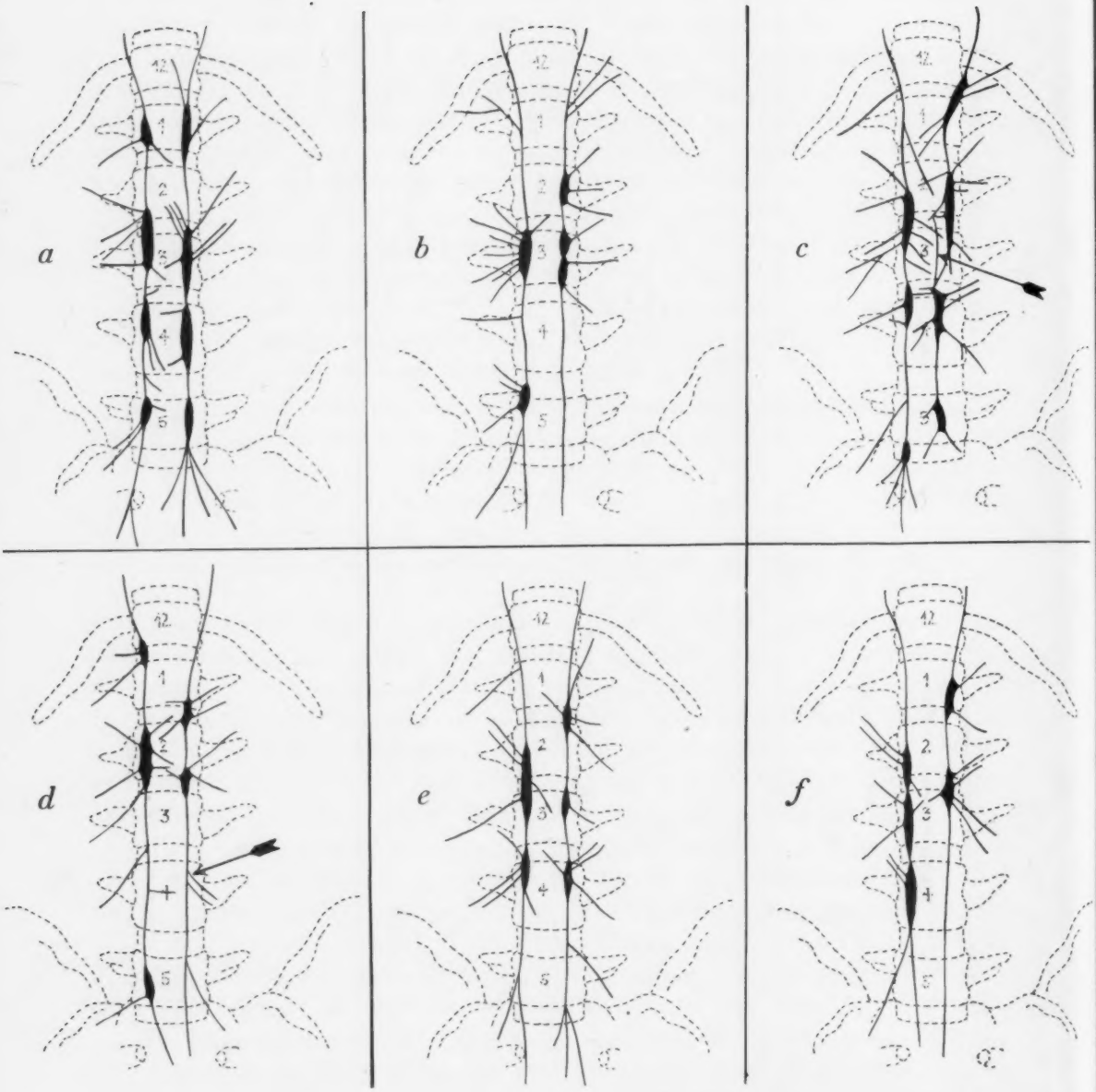

Fig. 3.—*a*, Shows paired ganglia on each of the vertebra except the second lumbar vertebra. *c*, Arrow points to a communication with the aortic plexus and the ganglion below. *d*, Arrow shows branching without gross evidence of a ganglion, which is not uncommon.

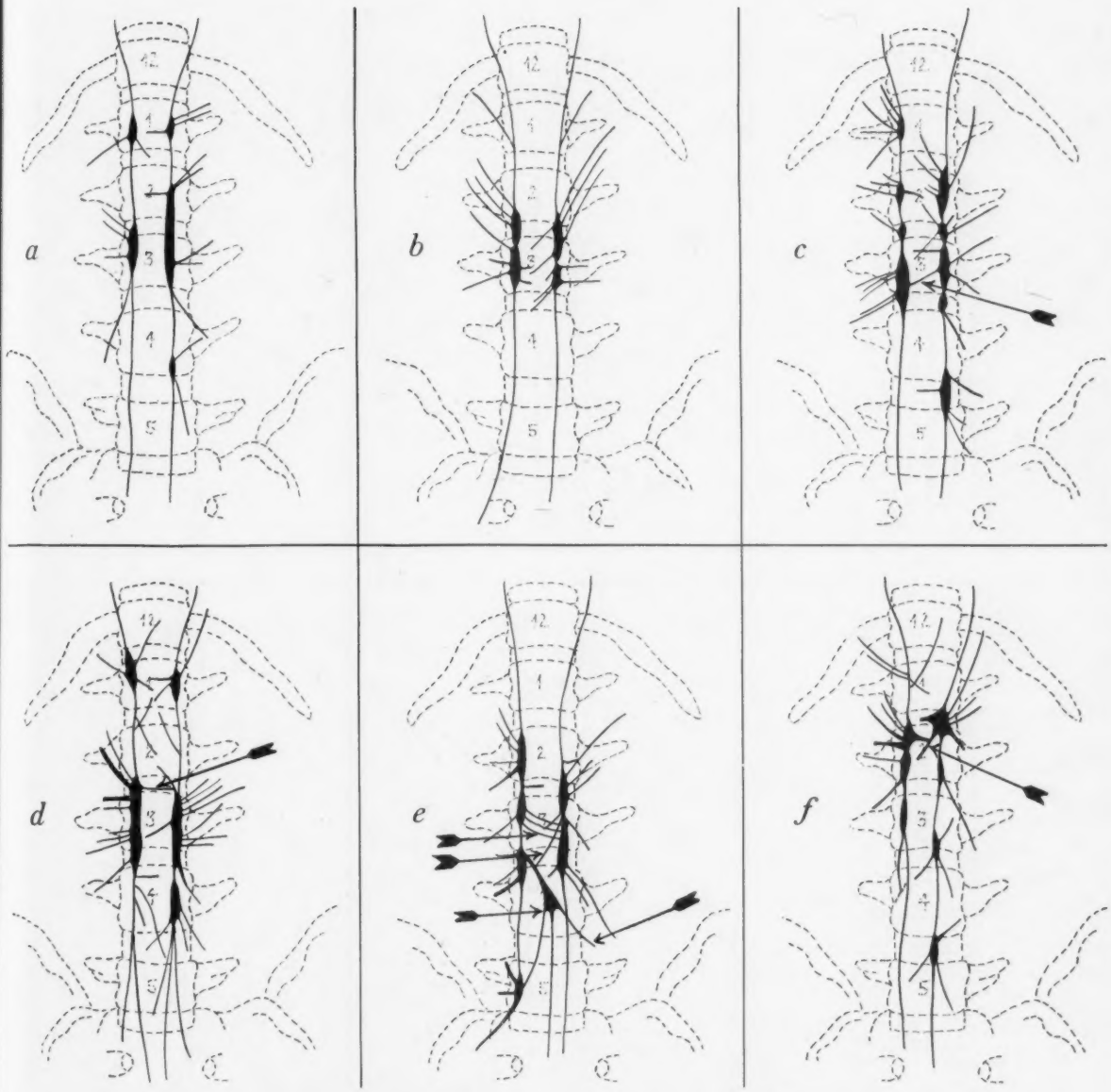

Fig. 4.—*c, d,* Note cross communication, also the number of branches given off. *e,* Arrow points out communications and double communications. Note one strand by-passing ganglion in the midline. This same ganglion is directly giving off a branch to the opposite side. *f,* Note the large ganglion on the left side communicating with that on the opposite side. Note also the chain on the left side which is placed much more medially throughout its course.

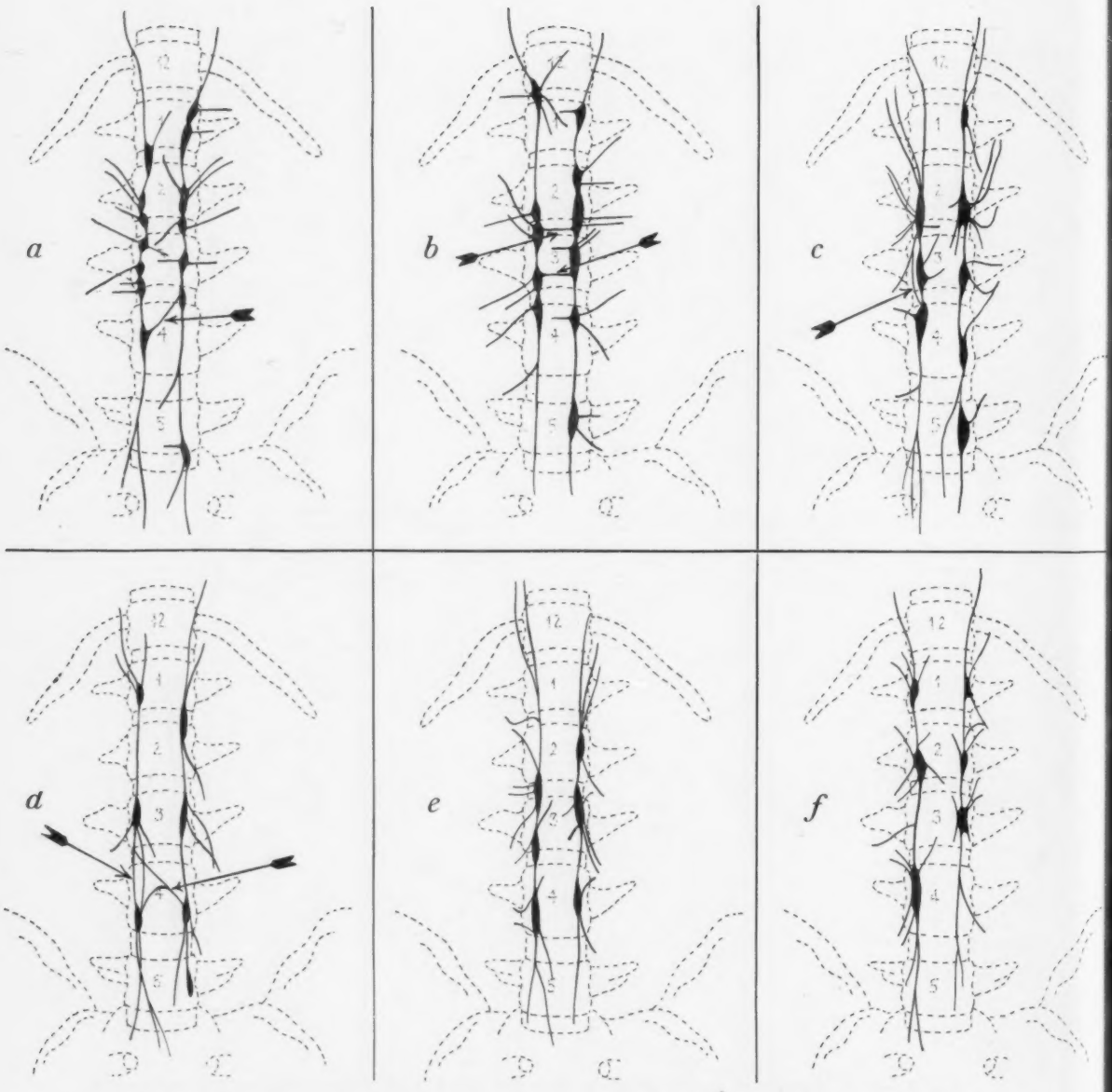

Fig. 5.—*a*, *b*, *c*, Arrows showing communications as described previously. *d*, Arrows demonstrating unusual communications on same and opposite sides.

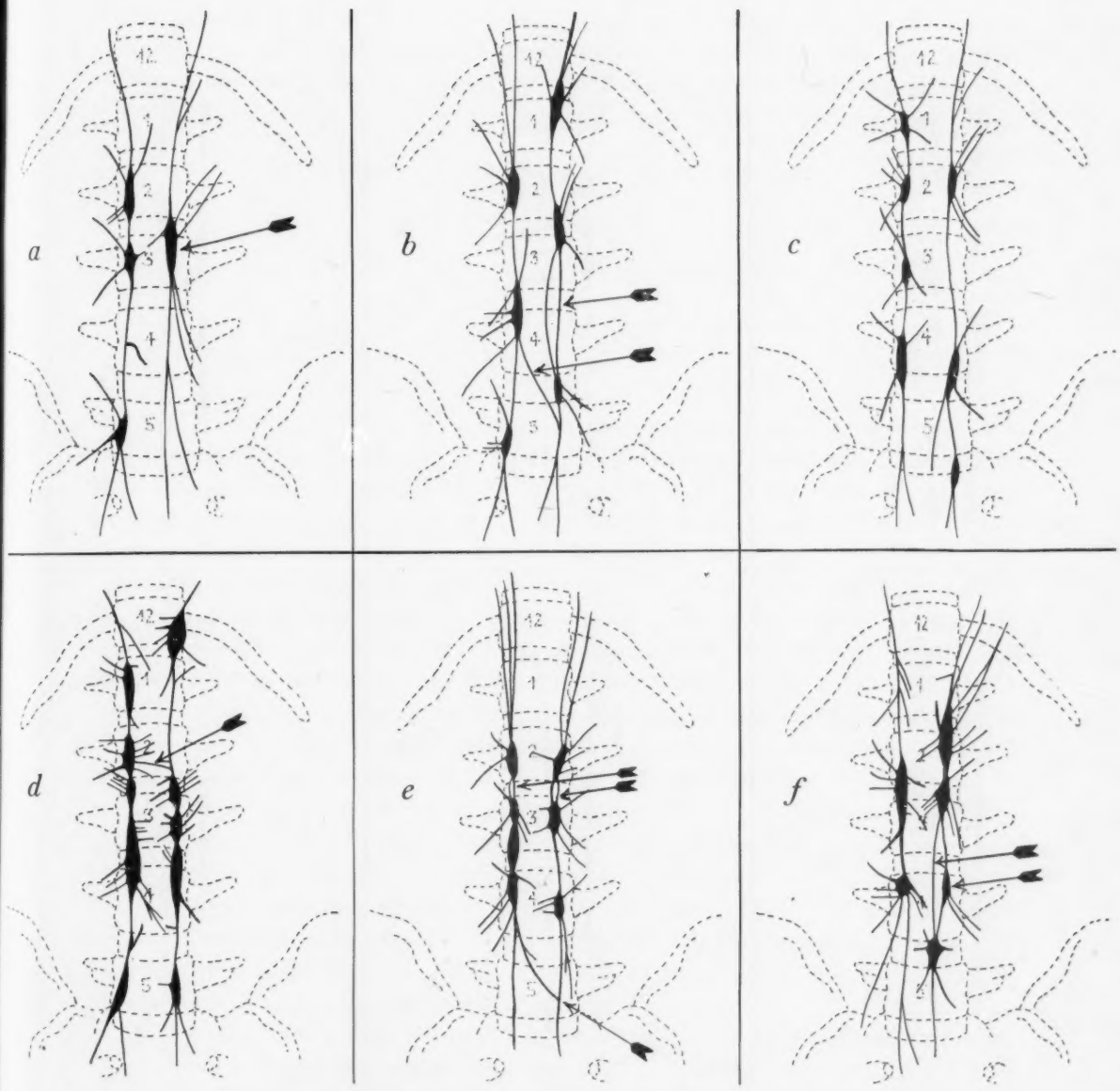

Fig. 6.—*a*, Arrow showing a single ganglion on the left chain. *b*, Arrows show cross and double communicating branches. *d*, Note marked fusion of ganglia on each chain, and the large number of branches given off. *e*, Double communications present on opposite sides at the same level. *f*, Arrows show one strand by-passing a ganglion to rejoin the chain distally.

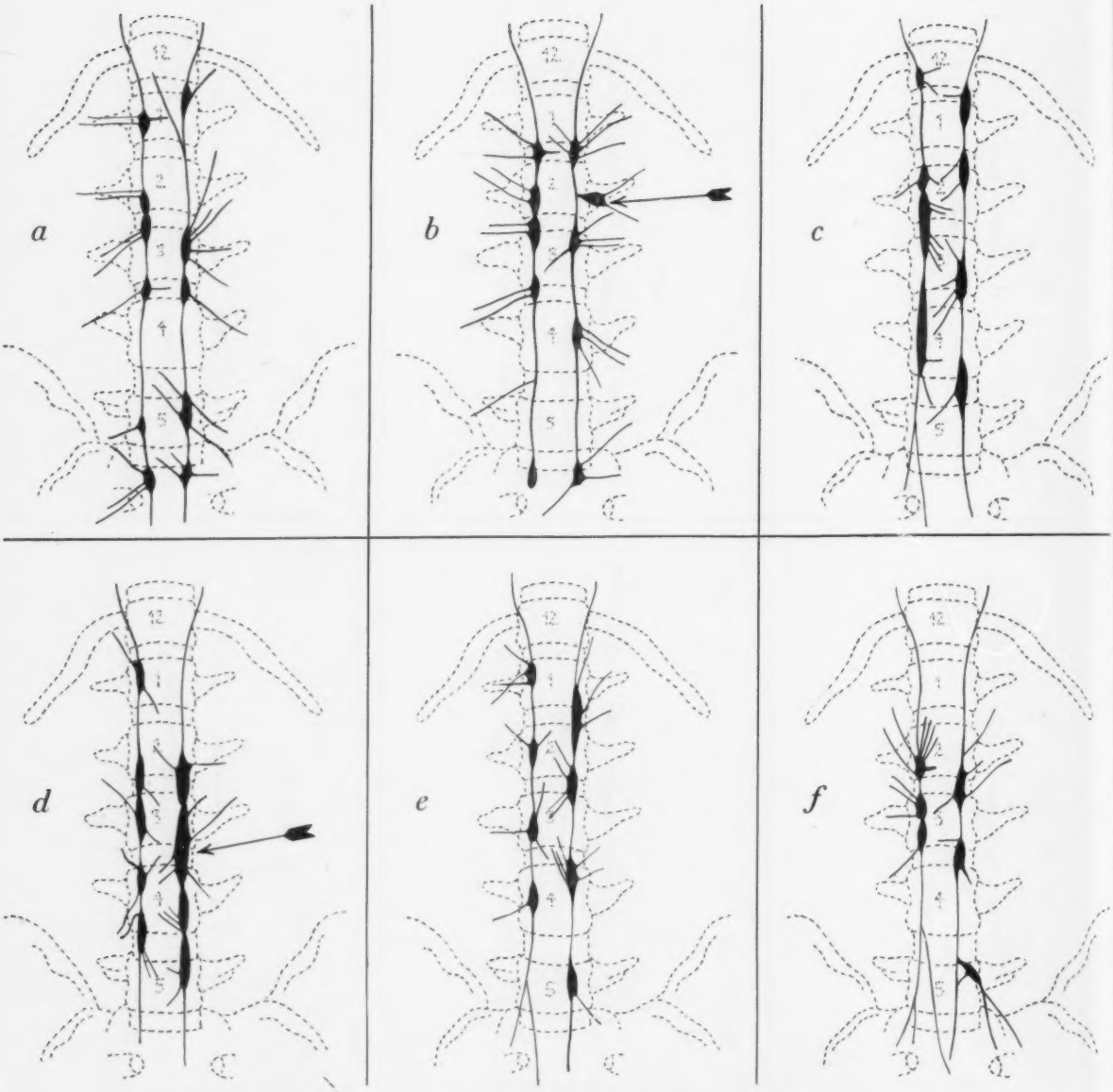

Fig. 7.—*b*, Arrow showing ganglion communicating with main chain by one branch. *d*, Note fusion of all of the ganglia on the left chain.

lumbar vertebra. It is extremely difficult to get proper exposure by lateral traction alone on this arch.

For a comparison of ganglia on the other vertebrae, see Table I. Note that ganglia are found most constantly on the second and third lumbar vertebrae. Those ganglia lying on the fifth lumbar vertebra were not charted. To expose this area in the extraperitoneal approach, marked lateral traction on the iliac vessels is necessary. These ganglia are found deeply imbedded in fascia and fat near the lower lateral border of the vertebral body, near the pelvic brim.

TABLE I. THE NUMBER OF TIMES LUMBAR GANGLIA WERE ABSENT IN A SERIES OF THIRTY-SIX DISSECTIONS

	ABSENCE, RIGHT SIDE	ABSENCE, LEFT SIDE	ABSENCE, BOTH SIDES
1st Lumbar Vertebra	13	10	8
2nd Lumbar Vertebra	3	5	1
3rd Lumbar Vertebra	3	3	1
4th Lumbar Vertebra	8	4	5

The number of lumbar ganglia in any given chain ranged from one to five, fused ganglia being counted as single. The average number of ganglia on each side was approximately three. If one attempts to differentiate the fused ganglia, the number ranges from one to seven on a single side. Fusion of two or more ganglia was not uncommon. The rami from a ganglion varied from one to ten; dissections were gross in character and it is probable that smaller filaments were destroyed without identification. The direction of the rami for an individual ganglion varied from cephalad and transversely to caudad. Ganglia located highest on the sympathetic chain have the greatest tendency for their rami to pass cephalad. This may help one in identifying which portion of the chain is under surgical attack, but it is not constant enough to tell the operator which specific ganglion is exposed. In our opinion, identification of an individual ganglion, by the number and direction of its rami, is unreliable.

In seven instances, one ganglion was connected to that more caudad, by two separate strands, and in one instance, one ganglion was connected to another by three separate strands. In three instances, fibers from one ganglion by-passed another ganglion to join the next ganglion further down. In several instances, one or more rami would deviate from the sympathetic chain without gross evidence of a ganglion in that vicinity.

Cross communications between the two sympathetic chains by one or more branches were found ten times. For any single specimen, the number of cross communications ranged from one to four.

In the entire series, no two chains were similar and no pattern of variation could be established. There were no predominant characteristics for either sex. The age range studied was from a stillborn male to an 83-year-old female (see Figs. 2, 3, 4, 5, 6, and 7).

Lumbar arteries and veins passing anterior to the sympathetic chain were an infrequent occurrence, and were usually observed only in the region of the fourth lumbar vertebra. The most constant ganglion, on both the right and

left sides, was found on a portion of the second lumbar vertebra, usually its lower third, or crossing the intervertebral substance to lie on the body of the third lumbar vertebra. Its rami, both in number and direction, were extremely varied. It was usually the largest of the lumbar ganglia, and when palpating for the sympathetic chain, the most easily identified.

As a matter of practical operative importance, it is suggested that the body of the fourth lumbar vertebra can be identified by the overlying aorta, bifurcating into the common iliacs. The first lumbar vertebra can be identified by the mediolumbocostal arch. If a ganglion is present on the first lumbar vertebra, it is usually not seen, since it is covered by this structure. For adequate denervation, sympathetic tissue should be removed between these two points. This excision should include a careful search for communicating strands, between the ganglion and fibers from the contralateral chain.

Sympathetic tissue overlying the fourth and fifth lumbar vertebrae is usually obscured by the common iliacs. Removal here is often hazardous and, under such conditions, not advisable.

SUMMARY

1. Many disappointing results following sympathectomy are due to a misunderstanding of the variables in the anatomy of the lumbar sympathetic chain.

2. Inconsistent characteristics of the lumbar sympathetic chain are demonstrated and analyzed in a series of thirty-six fresh autopsy dissections. Fourteen additional cadaver studies were made.

3. The most constant ganglion appeared on some part of the body of the second lumbar vertebra, or on the upper half of the third lumbar vertebra.

4. This study confirms the impression that individual sympathetic ganglia cannot be identified by anatomic position or by characteristics of the rami.

5. Requisites to assure an adequate lumbar sympathectomy are discussed from the anatomic viewpoint.

CONCLUSION

Thorough familiarity with anatomic characteristics and variations of the lumbar sympathetic chain is a requisite of the utmost importance to assure adequate lumbar sympathetic denervation.

REFERENCES

1. Swan, Joseph: A Demonstration of the Nerves of the Human Body, London, 1834, Longmans, Green & Co.
2. Walter, Johannis Gottlieb: Tabulae nervosum thoracis et abdominis, Berolini, 1783, Hirschwaldsche Buchhandlung.
3. Hirschfeld, Ludovic: Traite et iconographic du symteme nerveux et des organes des sens de l'homme, ed. 2, atlas, Paris, 1866, Victor Masson et Fils. (Neurologie et Esthesiologie.)
4. Hovelacque, A.: Anatomie des nerfs craniens et rachidiens et du systeme grand sympathique chez l'homme, Paris, 1927, Gaston Doin & Cie.
5. Atlas, L. N.: Sympathetic Denervation Limited to the Blood Vessels of the Leg and Foot, II, Ann. Surg. **116**: 476-479, 1942.
6. Livingston, W. K.: Clinical Aspects of Visceral Neurology, Springfield, Ill., 1935, Charles C Thomas, Publisher, p. 180.
7. Yeager, G. H., and Cowley, R. A.: Anatomical Observations on the Lumbar Sympathetics With Evaluation of Sympathectomies in Organic Peripheral Vascular Disease, Ann. Surg. **127**: 953-967, 1948.

A NEW METHOD OF PREVENTING THE FATAL EMBOLUS

Preliminary Report

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MUCH has been written on the subjects of phlebothrombosis, thrombophlebitis, and fatal pulmonary emboli. Those of us who write about it hope to contribute, little as it might be, to the prevention of the fatal embolus. Any fairly active surgical service will usually have at least one case demonstrating or just recovering from one of the venous thrombotic lesions or its complications. Although the service may be free of such a lesion for the moment one can be assured that the syndrome will soon appear. It is so certain to occur that one might repeat the remark made by President Coolidge to a friend when he stated, "It might rain"; the President answered, "It always has." Every physician can recount the terrifying experience of having a patient who is on the verge of being dismissed from the hospital suddenly die from a pulmonary embolus. In fact, it is so common an occurrence that most laymen have had such an experience with relatives or friends, so that they fear surgery because of the danger of "the formation of a blood clot." Many patients ask the question, "Has the time passed when there is no longer danger of experiencing a blood clot?"

The nonfatal embolus carries with it great morbidity, suffering, anxiety, and prolonged hospitalization. The incidence of the nonfatal embolus is much more common than most physicians suspect. It is often a signal that the fatal embolus is to follow. A nonfatal embolus is often a warning that a second embolus will follow. There is approximately a 30 per cent chance of a second embolus occurring and it carries a 20 per cent chance of being fatal. When a nonfatal embolus occurs with attending symptoms of shock there is little doubt regarding the syndrome. Many emboli lodge in the lung and do not produce dramatic symptoms. The patient may describe the episode to the physician making rounds but is disregarded with the reassurance that everything is fine. Other nonfatal emboli shower the lungs and leave their only symptom—a degree or two of fever which the surgeon may regard as a normal postoperative fever.

The morbidity of the sequelae of thrombophlebitis or venous ligation accounts for many a prolonged hospital stay. The purpose of this paper is to discuss a method of preventing the orginal mechanism that starts the fatal embolus on its journey. There is no doubt that the great majority of pulmonary emboli originate in the lower extremity. Many emboli which are removed from the pulmonary artery duplicate the branches, valves, and the markings of Zahn as they are seen in the veins of the leg. Many emboli arise in the veins of the lower extremity and clinically there are no symptoms referable to either leg to indicate the etiology. However, autopsy findings in such a case would

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likely show minute thrombi extending deeply into the tissues of the calf of the leg.

What is the mechanism that starts the sequence of events ending with the fatal embolus? Why do most emboli arise in the leg? There are two main contributing factors: (a) lack of muscular action; (b) pressure. Muscular activity, whether it be that which produces visible motion or simply that which gives tone to the muscle, is necessary in returning blood from the leg. Pressure over any area which either obstructs the return flow of blood or which causes ischemia of the tissues over a prolonged period of time aids in setting the stage for the formation of thrombi. They are further enhanced by damaged or varicose veins. The patient who suffers from a pulmonary embolus following a long automobile or train ride, the motionless bedridden individual, or those in sedentary occupations are subject to these etiologic factors. Further support of the explanation for the mechanism of formation of emboli is found in the fact that there is a low incidence of fatal emboli in thoracic surgery and pediatric surgery. In thoracic surgery the low incidence of emboli is due to the fact that the patient is in the lateral prone position where there is no pressure on the calf of the leg. If, however, the prone position be used where the patient lies on his back, pressure on the calf of the leg is present and the incidence of embolism rises. Likewise, in pediatric surgery the weight of the leg is so little that the effect of pressure is minimal. Postoperatively one need not fear inactivity in the case of the child.

The most important situation involved, and the one concerning this report, is that of the surgical patient who experiences prolonged pressure on the completely paralyzed muscles of the calf of the leg. This treatise particularly deals with the patient in Trendelenburg position, where he literally hangs by the calves of the legs. A very tight belt applied above the knees further aggravates the pressure and the resulting ischemia. The very obese extremity, the extremity with varicose veins, and the aged individual with flaccid musculature are even better candidates for thrombus formation than the usual patient. A long recovery stage of anesthesia may still further prolong the two- or three-hour paralysis. Would one apply a blood pressure cuff inflated to 100 mm. of mercury and leave it for three hours without expecting serious results?

The following apparatus was designed to prevent prolonged pressure with resulting ischemia and to produce the compression-relaxation movements which aid circulation in the leg. It was designed to work simply, noiselessly, and automatically so as to be of no burden to anyone in the operating room. Likewise, it was designed to be free of motors and thus lessen the danger of igniting explosive gases. The apparatus consists of an inflatable rubber bladder constructed to conform to the shape of the foot and leg. The bladder completely encircles the foot and leg as far as the popliteal fossa. The bladder is large enough to encircle the obese leg or simply overlaps when used on the thin extremity. The anterior and posterior compartments about the foot each connect with the anterior and posterior compartments about the leg by means of a small air channel.

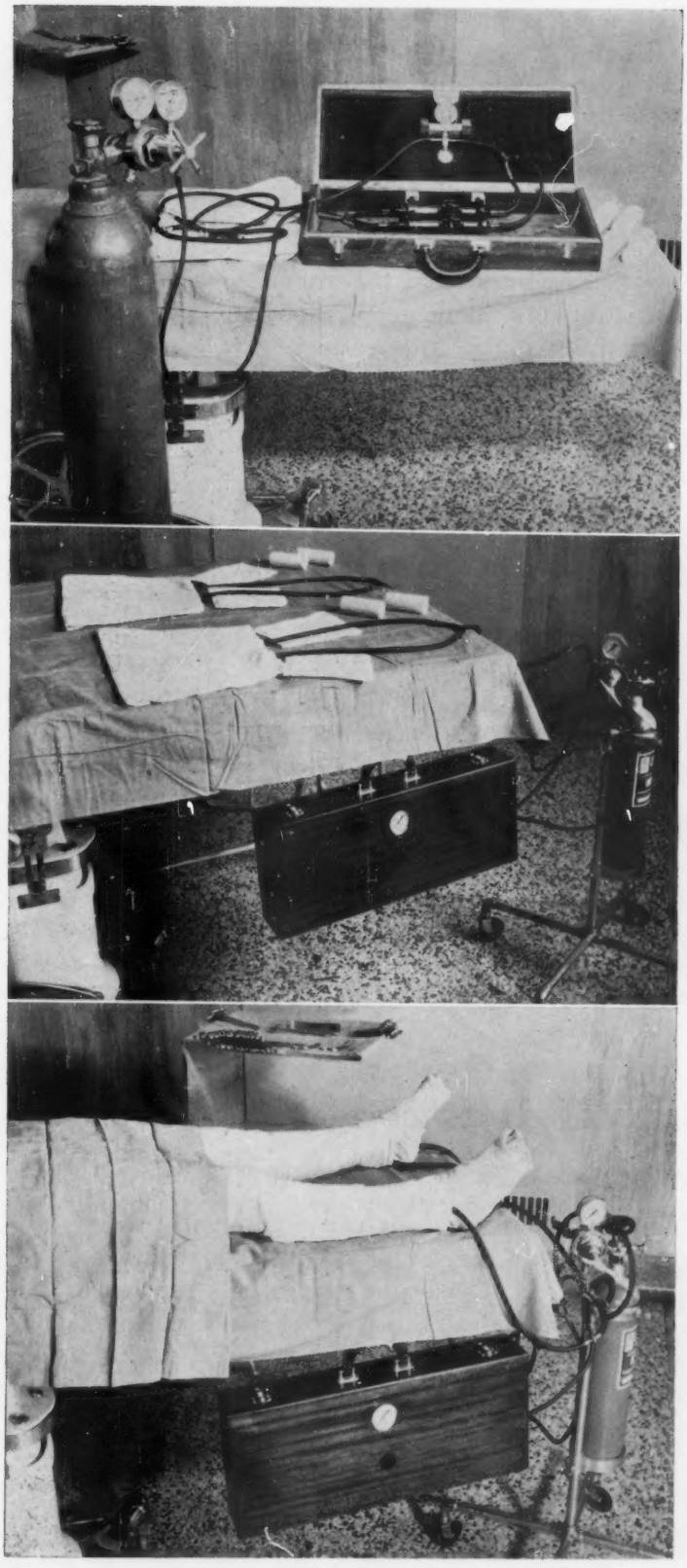
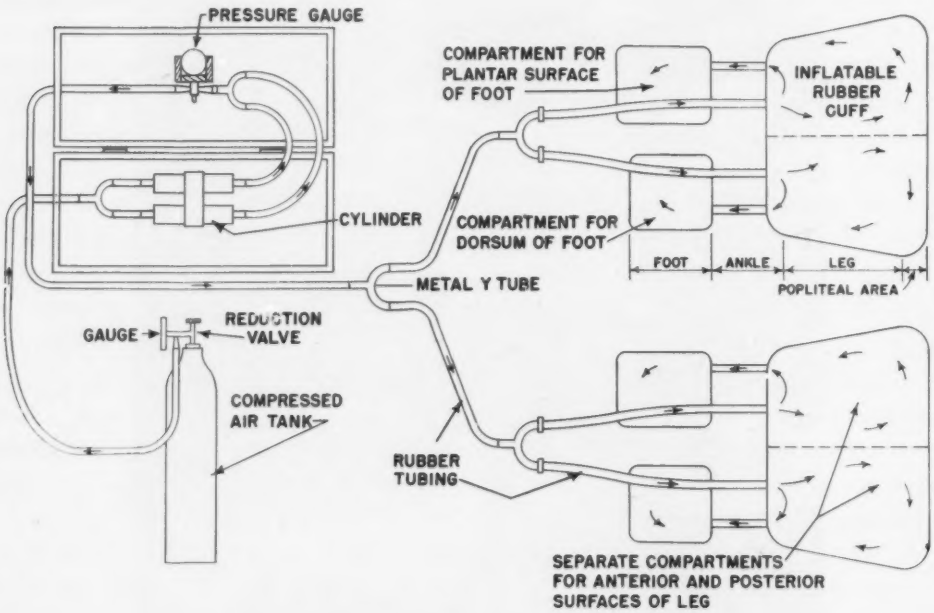


Fig. 1.

This was designed for two reasons: (a) to aid free flow of air by preventing angulation and wear at the "turn of the heel"; (b) to allow the use of restraining anklets instead of a belt above the knees. All compartments of both bladders then connect with a small mechanism. The latter is cylindrical in shape and measures 18 by 12 by 4 cm. Air enters the apparatus from a tank containing compressed air. When the piston reaches a certain point in the cylinder a valve allows escape of air. This produces the "expiration" of the cycle. "Inspiration" occurs when the piston moves in the opposite direction. The number of excursions taking place per minute can easily be regulated by means of a small valve at the distal extremity or by regulating the amount of air entering the apparatus from the tank. There need not be many cycles or excursions, since the purpose of this apparatus is to cause compression and relaxation only often enough to prevent stasis of blood and pressure ischemia.



PNEUMATIC CIRCULATOR DIAGRAM

Fig. 2.

We have found that one liter of air per minute will produce approximately 3 excursions per minute. A very small amount of air is necessary. Attachments are designed to fit any of the current oxygen tank regulators. The circulating nurse is the logical individual to supervise the mechanism, once it has been applied to the extremities. Thereafter it requires little or no care. We feel that this apparatus is the answer to the prevention of pulmonary emboli.

COMMENT

We discarded the idea of using an inflatable mattress which conformed to the contour of the body. We felt that few emboli arose from parts of the body other than the legs. It was also considered too cumbersome, too expensive, and

requiring endless care. Likewise, we discarded all pressure suction apparatuses because they simply supply "milking-action" but do not lift the calf of the leg from the table to relieve the pressure. Our apparatus permits the surgeon to use Trendelenburg position which is often necessary. A third method of attacking the problem by various means of suspension of the legs solved the pressure problem, but the musculature was still lacking in tone and motion. The Trendelenburg position could not be used under these circumstances because shoulder braces would necessarily be needed to control the weight of the body. Injury to the brachial plexus under these circumstances occurs.

It is easy to designate the origin and follow the pathway of a pulmonary embolus. Pressure on the calf of the leg such as occurs in all types of surgery, but especially in pelvic surgery, causes an ischemia of the tissues. This results in damage to the minute blood vessels with inevitable thrombosis. The latter grows by addition until it reaches the femoral vein and the period of time necessary for this is about ten days or two weeks (about the time the patient is allowed out of bed in late ambulation or is ready for dismissal). As the large thrombus waves freely in the femoral and iliac veins, the patient flexes the thigh and may amputate the segment of thrombus which extends above the ligaments. This starts it on its mission of death. There may or may not be symptoms or findings indicating its source. Should the indication of the origin of the thrombus be absent, we would under present therapy initate anticoagulants and ligate both common femoral veins, the iliacs, or vena cava. None of these measures is without serious sequelae.

Early ambulation has decreased many postoperative complications but it has not lessened the incidence of fatal pulmonary emboli. The explanation is that the damage was done while the patient was on the operating table. Little can be done, including early ambulation, to stop the process of thrombus formation once it has been initiated. Our apparatus or similar apparatus must stop it before it is initiated.

Anticoagulants are a welcomed prophylactic measure and explain the good results when used postoperatively in patients who give a history of previous phlebitis. The danger of postoperative hemorrhage in their routine use, however, is well recognized.

All such measures are lifesaving when used at the proper time, and this paper does not minimize their importance. Perhaps, by preventing the initial step in the formation of the embolus, all of the complications arising from phlebothrombosis and thrombophlebitis might be avoided. Prophylactic measures should not end when the patient leaves the operating table. The legs should not be motionless except for short periods of time until muscle tone has been regained. The position of the legs must be changed often and if pressure be unavoidable it is preferable to have it on the lateral surface of the leg instead of on the posterior surface. We have originated a position to prevent pressure on the calves. Our nurses refer to it as the McCarthy sole-to-sole position. Briefly, we place the legs in slight flexion abduction and with the soles of the feet approximating each other; all pressure postoperatively is thus far from the

calves. We also are using our apparatus, the Pneumatic Circulator, during the immediate postoperative period. Pressure should also be avoided on the popliteal area such as that which results from pillows, crossing the legs, and the elevation of the knee.

Briefly, the calves of the legs require so much attention, not only during the operation but postoperatively, that one might well caution—"take care of the calves 'til the cows come home."

CONCLUSIONS

1. The majority of emboli arise in the legs, more specifically in the calf of the leg. The importance of sequelae of such thrombi, despite current methods of therapy, has been described.

2. The sequence of events occurring in the formation of a fatal embolus has been described.

3. The use of an apparatus, the Pneumatic Circulator, designed to prevent the initial event has been presented.

CLINICAL STUDY OF THE USE OF A SYNTHETIC DETERGENT (PHISODERM) COMBINED WITH HEXACHLOROPHENE FOR DISINFECTION OF THE SKIN

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INTRODUCTION

PREOPERATIVE sterilization of the skin of patient and personnel has been shown to be the weakest link in the chain of sterile technique.[1] Multiple techniques have been evolved for the evaluation of skin detergents and germicides.[2, 3] From the experimental screening, a combination of synthetic ether sulfonate detergent compound with a new antiseptic* has been selected for clinical trial.

RATIONALE

Reports by Traub[4, 5] have shown that during the routine use of two per cent Hexachlorophene (2,2′-Dihydroxy-3,5,6-3′, 5′6′ Hexachlorodiphenylmethane) in soap, the resident bacterial flora of the skin were decidedly and permanently reduced, and that the residual bacterial count, after two minutes of washing with Hexachlorophene soap in an exclusive user was lower than after a twenty-minute scrub with ordinary soap in a soap user. A thousandfold reduction from the normal skin counts was found with the use of 1 per cent Hexachlorophene in liquid soap by Seastone,[6] who concluded that apparent retention of Hexachlorophene by the skin resulted in a cumulative bacteriostatic effect on the resident flora. Thirlby and Vial,[7] in a study of the pathogenicity of handwashings injected into sensitized mice, found that a two-minute wash with Hexachlorophene is superior to a ten-minute scrub with soap, and that hand contaminations with virulent Streptococci were immediately cleared up in Hexachlorophene users, whereas soap users showed heavy contamination seventy-two hours later despite daily soap scrubs.

Guild[8] showed that pHisoderm, a detergent cream composed of a sulfonated ether petrolatum, lactic acid, and wool fat cholesterols, possessed active emulsifying, sudsing, and dispersing properties with a surface activity estimated to be about 40 per cent greater than that of soap. It yielded no objectionable end products on hydrolysis, and, having a pH of 5.5, preserved the normal acid pH of skin. Hufnagel, Walter, and Howard,[3] in a comparative study of multiple determinations of the flora of skin under standardized mechanical conditions after the use of various detergents and germicides, showed that 3 per cent Hexachlorophene in a sulfonated detergent (pHisoderm) displayed the most rapid disinfecting action.

Presented in the Forum on Fundamental Surgical Problems, at the Clinical Congress of the American College of Surgeons, Los Angeles, Calif., Oct. 18 to 22, 1948.

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*Supplied through the courtesy of Winthrop-Stearns, Inc., New York, N. Y.

PRESENT STUDY

In view of the experimental evidence presented of the superiority of the combination of pHisoderm and Hexachlorophene, we attempted a clinical trial of this material. For four months (April 15 through Aug. 15, 1948), throughout the entire surgical services, 3 per cent Hexachlorophene in pHisoderm, exclusively, was used for preparation of the skin of patient and personnel as outlined here.

Cognizant of the many variables in a clinical test, we attempted to reproduce the conditions present during the same period of time (April 15 through August 15) for the previous year (1947). Prior to the institution of the 3 per cent Hexachlorophene in pHisoderm technique, all operative sites were prepared by a ten-minute scrub with soap, followed by alcohol, ether, and Zephiran. Hands of the personnel were prepared by the usual ten-minute soap scrub followed by a one-minute wash in alcohol. No attempts were made to change the operative technique by any directions to medical or nursing personnel. All other germicides were removed, soap dispensers replaced by those for pHisoderm and Hexachlorophene compound, and instructions issued for routines as will be described. Although there has been a definite increased interest in wound healing because of the obvious, careful scrutinization of the results, no other changes have been added. Of the operative procedures, 90 per cent are carried out by the junior staff corresponding to the status of residents. Only nonabsorbable suture material is used.

The routine skin preparation used is as follows:

Personnel Hand and Arm Scrub

1. Scrape the subungual spaces with tip of nail file.
2. Wet hands and arms thoroughly. Using one shot of detergent on skin of each hand (2 c.c.), wash arms and hands for one minute. Rinse completely.
3. Repeat, and, using brush, develop anatomic scrub so that *every area* of the skin receives 15 brush strokes and the nails, 25.
4. Rinse with tap water.

This takes two minutes.

Patient's Skin Preparation

Apply pHisoderm with Hexachlorophene to the skin, and, using gauze sponges wet in sterile water, develop a lather. Shave the area, wipe clean, add 5 c.c. of the agent, and continue the scrub for four minutes. Wipe off the lather with a wet sponge and blot dry with a sterile towel.

In vascular, plastic, and orthopedic cases the scrub is repeated daily four days prior to surgery. Other elective cases have the operative area prepared the evening before. Emergencies have but one preparation. No other antiseptic is used at any time. Prior to removal of sutures and as part of every dressing, the wound is washed carefully with pHisoderm with Hexachlorophene for one minute and the suds removed with a moist sponge.

All wounds were classified as clean, potentially contaminated, or infected. No infected wounds were closed primarily. Wound healing was assayed as to primary union, reddened skin edges, increased induration, stitch abscess, partial wound infection, and total wound infection. Seromas and hematomas were cultured but, if the cultures were negative, were not reported as infections. All wounds which primary closures were attempted are included with the exception of those drained over forty-eight hours (urethrolithotomy, etc.) or those with bowel fistulas opening directly in the wound.

RESULTS

In a comparable period (April 15 through August 15) for 1947, employing routine preparation with soap in 368 operative procedures, our infection rate was 8.2 per cent for all types of cases. In the present series a total of 328 wounds were examined with seven infections, or an over-all rate of 2.1 per cent (Table I). There was an infection incidence of 1.3 per cent in 239 clean operative wounds; 89 contaminated wounds had an infection incidence of 4.5 per cent (Table II).

TABLE I. COMPARATIVE INCIDENCE OF INFECTIONS

		CASES	INFECTIONS	PER CENT
April 15 to Aug. 15, 1947	Routine skin preparation	368	30	8.2
April 15 to Aug. 15, 1948	3% Hexachlorophene in pHisoderm	328	7	2.1

TABLE II. WOUNDS STUDIED DURING TRIAL OF PHISODERM AND G-11

	WOUNDS	INFECTIONS	PER CENT
Clean			
Major	169	1	
Minor	70	2	
	239	3	1.3
Contaminated			
Major	79	4	
Minor	10	0	
	89	4	4.5
Total cases	328	7	2.1

The seven infections (Table III) included one moderately serious infection in a massive hematoma and six inconsequential infections of which five were in potentially contaminated cases. Table IV compared certain specific groups of cases over comparable periods in 1947 and 1948, the former prepared with soap technique, the latter with Hexachlorophene and pHisoderm.

TABLE III. WOUND INFECTIONS DURING APRIL 15 TO AUG. 15, 1948

WOUND INFECTION	OPERATION	CULTURE	DAY POSTOPERATIVE DETECTED
1. Infected hematoma	Herniorrhaphy	Mixed	21
2. Stitch abscess	Axillary dissection	Staph. albus	5
3. Increased induration and seroma	Gastrectomy	No growth	14
4. Partial	Appendectomy (ruptured)	Streptococci	5
5. Partial	Appendectomy (ruptured)	Streptococci	5
6. Partial	Hemicolectomy	B. coli	14
7. Complete	Skin graft to granulated wound	Staph. aureus	10

TABLE IV. COMPARISON OF CERTAIN CLASSIFIED GROUPS
(For April 15 to Aug. 15, 1947 and 1948)

TYPE OF OPERATION	CASES	INFECTIONS
Herniorrhaphy		
'47	79	3
'48	50	1
Vascular		
'47	14	0
'48	10	0
Orthopedic (Open)		
'47	8	0
'48	18	0
Plastic		
'47	40	4
'48	46	1
Appendectomy		
'47	43	3
'48	46	2
Gastric		
'47	10	1
'48	10	1
Pilonidal cystectomy		
'47	16	7
'48	7	0

It is recognized that the months selected (April, May, June, July, and August) have the lowest rate of air-borne infection,[9] but it must also be recognized that especially during the latter two months in Texas, the outside temperature is often well over 100° F. and, as the majority of our wards are not air-conditioned, the increased heat and perspiration potentially permit more preoperative and postoperative wound contamination than during the cooler months.[10] This should have been most marked in those open bone cases requiring casts for a prolonged period of time. Nonetheless, the eighteen open operations with casts showed no evidence of redness, induration, or stitch abscess. It is interesting to note the marked incidence of wound infection in the 1947 series of pilonidal cysts and its total absence in the present very small series. In this clinic all wounds after pilonidal cyst excisions have been closed primarily with fine cotton sutures. No detail in technique has been altered in this brief series except for the preoperative skin preparation.

COMMENT

Although there was noted a marked reduction in the rate of infection with the use of this preparation, we readily recognize that our small series and the limited period of time covered do not permit absolute conclusions. Our bacteriologic studies, although insufficient in number and hence unreported, have led us to believe that there is a more prolonged decrease in the resident bacteria present under the dressings of those cases prepared by the four-day pHisoderm and Hexachlorophene preparation as compared with those prepared with the soap, alcohol, ether, and Zephiran routine. Those studies are being repeated in conjunction with our continued clinical trial throughout all seasons of the year.*

*We have just completed a clinical trial of the use of this preparation for one calendar year and find that our results are consistent with those reported herein. These will be presented in a later paper.

The entire surgical staff has been impressed by the simplicity of the technique, the reduction in time consumed, and the immediate excellent results. There have been no evidences of skin reaction in either patients or personnel. Despite the reported inactivation of Hexachlorophene by serum, we have used it in the mechanical cleansing of traumatic wounds prior to closure, and in the débridement of extensive burns with resultant kindly wound healing, with no evidence of tissue trauma to date, and no infection. We have advocated its use with the isolation technique in cases of infectious diseases, in the preparation of body surfaces prior to the application of plaster of Paris casts, and at no time have we seen evidences of skin reaction or folliculitis. It is recognized that the kind of skin disinfectant employed is but one of many factors in wound healing and we can but quote Walter, "The magic of skin disinfection lies in the skill with which it is mechanically cleansed."

CONCLUSIONS

1. Brief clinical trial of 3 per cent Hexachlorophene in pHisoderm in the preoperative preparation of the skin of the hands of the operating personnel and of the operative site has corroborated experimental evidence that it is a rapid, atraumatic, nonsensitizing disinfectant detergent of wide application.

2. In a small series over a limited period of time the incidence of all wound infections in clean and contaminated cases has been decreased to one-fourth of a control series.

3. The question as to whether the use of Hexachlorophene in pHisoderm will permanently decrease the incidence of our postoperative wound infections due to skin bacteria can be answered only by further observations in a larger series of cases.

REFERENCES

1. Lovell, D. L.: Preoperative Skin Preparation With Reference to Surface Bacteria Contaminants and Resident Flora, S. Clin. North America **26**: 1053-1059, 1946.
2. Price, P. B.: Bacteriology of the Normal Skin: New Quantitative Test Applied to Bacterial Flora and Disinfectant Action of Mechanical Cleansing, J. Infect. Dis. **63**: 301-318, 1938.
3. Hufnagel, C. A., Walter, C. W., and Howard, R. W.: An In Vivo Method for Evaluation of Detergents and Germicides, SURGERY **23**: 753-759, 1948.
4. Traub, E. F., Newhall, C. A., and Fuller, J. R.: Studies on the Value of a New Compound Used in Soap to Reduce the Bacterial Flora of the Human Skin, Surg., Gynec. & Obst. **79**: 205, 1944.
5. Traub, E. F., Newhall, C. A., and Fuller, J. R.: New Cutaneous Bacterial Agent Used in Soap, Arch. Dermat. & Syph. **52**: 385-388, 1945.
6. Seastone, C. V.: Observations on the Use of G-11 in the Surgical Scrub, Surg., Gynec. & Obst. **84**: 355-360, 1947.
7. Thirlby, R. L., and Vial, A. B.: Presented but unpublished.
8. Guild, B. T.: Cutaneous Detergents, Experience With an Ether Sulfonate Compound, Arch. Dermat. & Syph. **51**: 391-395, 1945.
9. Hart, Deryl, and Upchurch, S. E.: "Unexplained" Infections in Clean Operative Wounds, Ann. Surg. **114**: 936-959, 1941.
10. Lovell, D. L.: Skin Bacteria, Their Localization With Reference to Skin Sterilization, Surg., Gynec. & Obst. **80**: 174-177, 1945.
11. Walter, C. W.: Aseptic Treatment of Wounds, New York, 1948, The Macmillan Company, p. 231.

FULL-THICKNESS SKIN GRAFTS IN HERNIAL REPAIR

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THE purpose of this paper is to report a small series of cases using full-thickness skin in hernia repair, and animal experimental studies to demonstrate the fate of skin when buried.

Mair of Aberdeen, Scotland,[1] in 1938 was the first to use whole skin in hernial repair. He has reported 137 cases to date. More recently, Goodhall and Guthrie[2] reported the repair of six inguinal hernias using full-thickness skin. Their longest follow-up has been one year. These reports and that of Peer and Paddock,[3] as well as our own findings, suggest that full-thickness skin is as suitable a material for hernial repair as fascia or cutis grafts.

There are certain advantages in the use of skin as compared with fascia. Proved by animal experimentation, skin has longer life. Full-thickness skin can be obtained from the operative site.[1] The repair is stronger. The operative procedure is simple. Skin can be sutured firmly without tearing or splitting, and it takes readily. The use of small needles avoids damage to the remaining structures. The skin may be pulled in all directions without splitting. Burdick, Gillespie, and Higinbotham,[4] in reporting 975 carefully followed hernial cases in which fascia was used, found a recurrence in 284. This suggests that fascia is not the best material for hernial repair. Therefore, it is our opinion that a material offering the advantages of full-thickness skin is well worth investigation.

Cutis grafts, first used by Otto Loewe in 1939 in nine cases and subsequently utilized by numerous authors,[5, 7] have afforded good material for hernial repair. However, these grafts, if of adequate thickness, always contain epithelial elements and offer little advantage over full-thickness skin.

EXPERIMENTAL WORK

In our experimental work, fourteen dogs and six rabbits were used as subjects. Skin taken from the operative site was used to repair a surgical defect created in the rectus or lumbodorsal fascia. This skin was sutured under varying degrees of tension. At intervals these specimens were removed and examined microscopically. Fine cotton sutures were used throughout.

Buried skin has the tendency to undergo a replacement and adapt itself to the surrounding structures. Rehn[6] as early as 1914, and Uihlein in 1934,[8] demonstrated that tension brought about this change. When used in tendon replacements by Rehn[6] and Schwartz,[9] skin became altered in its structure and took on the appearance of tendon tissue. Grossly, in many instances it was difficult for us to differentiate the buried skin from the surrounding

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structures. In our animal experiments the change was confirmed microscopically. Since identical findings resulted in all the experimental animals used, a report of individual experiments is omitted.

Sebaceous glands were the first epithelial elements to disappear (see Fig. 1). They began to disappear as early as the second week and had vanished completely at four weeks. Peer and Paddock,[3] in human experiments with buried skin in the chest wall not under tension, found that the sebaceous glands survived for only one week. Hair follicles survived for a longer period

Fig. 1.—Buried rabbit skin removed at four weeks, note absence of sebaceous glands and beginning degeneration of hair follicles.

of time. However, we did not find evidence of continued hair growth in any removed specimen. It appeared in our sections that hair-follicle degeneration begins about the fourth week and continues until at five months no hair follicles are present.

The one disadvantage of buried skin is the possible formation of cysts (see Fig. 2). The formation of cysts is natural. Buried epithelium tends to bend upon itself forming a closed cavity or cyst, lined with epithelium.[10] In

those specimens not sutured under tension, this was a frequent finding. Even in those specimens sutured under tension, smaller cyst formation did occur. The cysts do not seem to increase in size. This finding was demonstrated only microscopically in our experimental animals; in no reported human case has evidence of cyst formation been observed clinically. Furthermore, the element of time appears to be a factor in the replacement of these cysts by fibrous tissue and in their eventual disappearance.[3] Foreign body cells do appear and low-grade inflammatory reaction is present. Peer and Paddock[3] showed

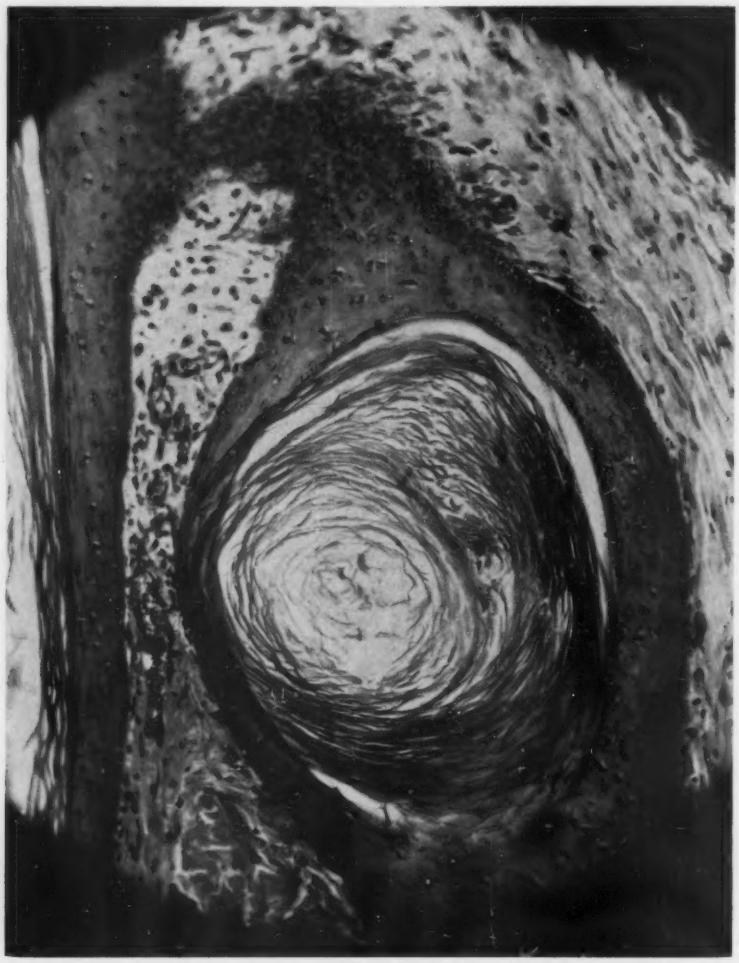
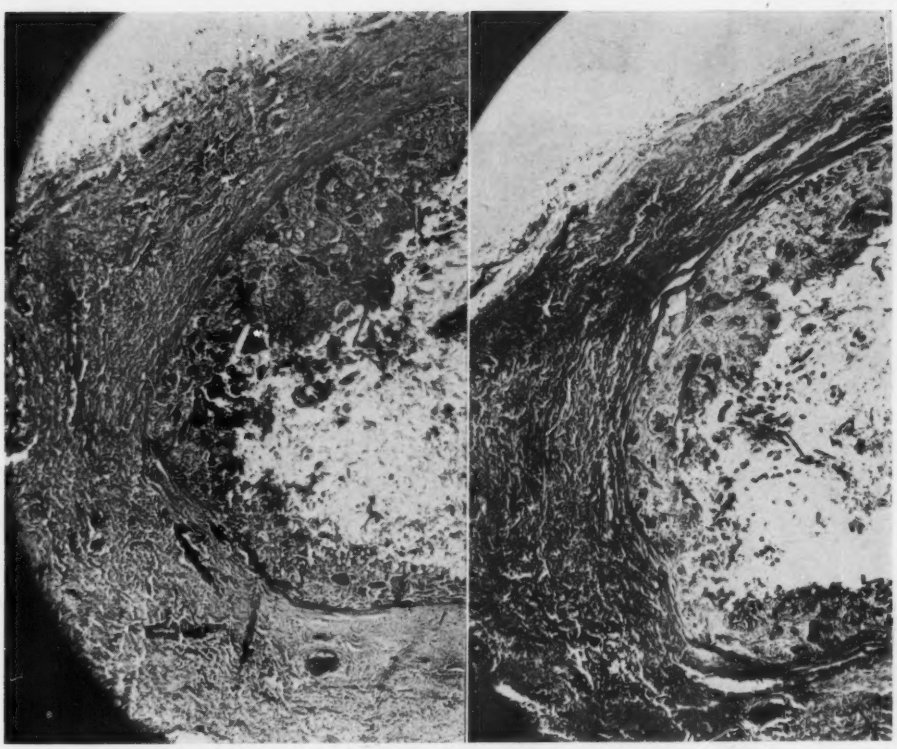


Fig. 2.—Section of rabbit skin removed at six weeks, note formation of cysts.

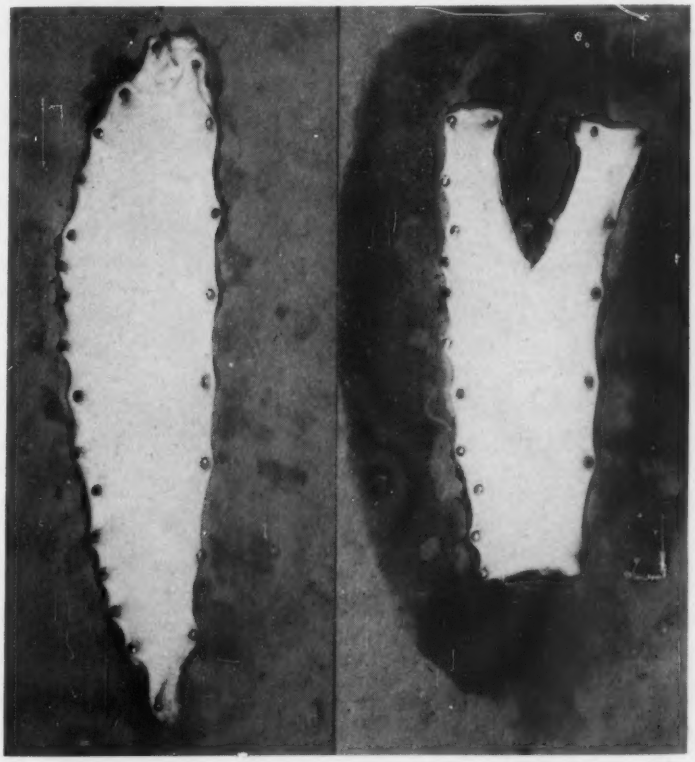
that at the end of one year small cystic cavities were still present, but the epithelial lining was replaced by collagenous fibers. In time, the cyst walls appear slowly to undergo degeneration and a change to connective tissue (see Fig. 3).

As no sweat glands existed in the animals used by us, we cite the work of Peer and Paddock[3] in this regard. This epithelial element was the last to disappear. Sweat glands in a very degenerated state were found up to one year.



A. *B.*

Fig. 3.—*A* and *B*, Buried rabbit skin removed at five months. *A*, Section shows cyst wall with complete replacement of epithelium with connective tissue. *B*, Another section from the same cyst wall using reticulum cell stain. Note: The animal was killed with intravenous India ink to demonstrate the blood supply.



A. *B.*

Fig. 4.—*A*, Skin removed for use as a graft. *B*, Preparation of skin for use in repair of an inguinal hernia. The graft is bisected for about one-third its length to permit passage of the cord at the level of the internal ring.

Fig. 5 (Case 2).—The graft is sutured to the shelving edge of Poupart's ligament and to the undersurface of the external oblique fascia; the reflected margin of the latter can be seen on the right. The limbs of the graft have not as yet been sutured together about the cord at the internal ring. Note: The underlying muscles and fascia had previously been sutured to Poupart's ligament.

Fig. 6 (Case 3).—Method of suturing limbs of graft about the cord. Note: This patient had been operated upon three times previously with recurrence.

PREPARATION AND TECHNIQUE FOR HERNIAL SKIN GRAFTS

The procedure for full-thickness skin grafts in patients is carried out with the following technique. Proper preparation of the skin is most important. First the area must be thoroughly shaved and next carefully scrubbed with ether, soap, and warm water for ten to fifteen minutes. Alcohol compresses are then applied and held in place with sterile dressings. This procedure is carried out daily for three days prior to operation. The skin for use as a transplant is obtained by an elliptical incision at the operative site. The next important step is the removal of all fat from the skin transplant. The skin should be sutured under extreme tension in all directions, because cyst formation seems to be related inversely to the degree of tension. Every attempt must be made to obtain complete hemostasis, and to avoid any dead space.

CASE REPORTS

CASE 1.—E. F., a 20-year-old soldier, received a penetrating gunshot wound of the left leg on April 13, 1945. There resulted a muscle hernia that protruded through a defect 3 by 5 cm. in the anterior tibial fascia. On Sept. 15, 1945, the scar was excised, and the fascial defect was isolated. A portion of skin removed from the thigh was used to repair the defect. This transplant lay directly beneath the subcutaneous tissue of the skin of the leg. For two weeks there was evidence of a moderate collection of fluid between the skin and the graft, but drainage did not occur and no aspirations were necessary. The man was discharged six weeks later with an apparent good result.

Note.—This case was selected first because it involved minimal risk.

CASE 2.—E. A., an obese man, 28 years of age, complained of a bulge in the right groin. Examination revealed a small indirect and a large direct hernia on the right. The direct hernia had rapidly increased in size during the previous month. Both hernias were repaired on Nov. 10, 1945. The skin transplant was obtained by means of an elliptical incision in the right inguinal region. The ends of the transplant were cut off, fat was removed, and the graft was bisected for about one-third of its length from one end. This skin was sutured to the shelving edge of Poupart's ligament, to the undersurface of the medial leaf of the external oblique fascia and the fascia over the rectus muscle insertion in the pubis. The two limbs of the split end were sutured around the cord, and then the transplant was covered by overlapping with the external oblique fascia. Recovery of this patient was no different than that in the usual hernial repair. The family physician recently reported no evidence of recurrence.

Note.—This case is now thirty-four months postoperative.

CASE 3.—E. S. had been operated upon three times previously for a right direct inguinal hernia. Repair of this recurrent hernia was done Dec. 29, 1945. The procedure was similar to that employed in Case 2. The cord was isolated with difficulty due to scar tissue. Also, Poupart's ligament was poorly identified because of the previous operative interventions. The postoperative course, however, was average and no drainage occurred. This patient's family physician reports that there is some atrophy of the right testicle but no evidence of recurrence of the hernia.

Note.—Should a similar case be encountered, it is our opinion that the lower or lateral margin of the transplant should be sutured to Cooper's instead of Poupart's ligament. Also, constriction of the cord by the transplant should be avoided or the cord and testicle should be removed.

CASE 4.—J. W. W. presented a large incisional hernia resulting from a previous exploratory operation done for a gunshot wound of the abdomen. The scar was approximately 10 inches in length; it was smooth and soft. The patient was operated on Dec. 10, 1945. A wide elliptical incision was made including the scar. The skin flaps were undermined widely and the large hernial defect was exposed. The sac was opened, excess peritoneum was excised,

Fig. 7.

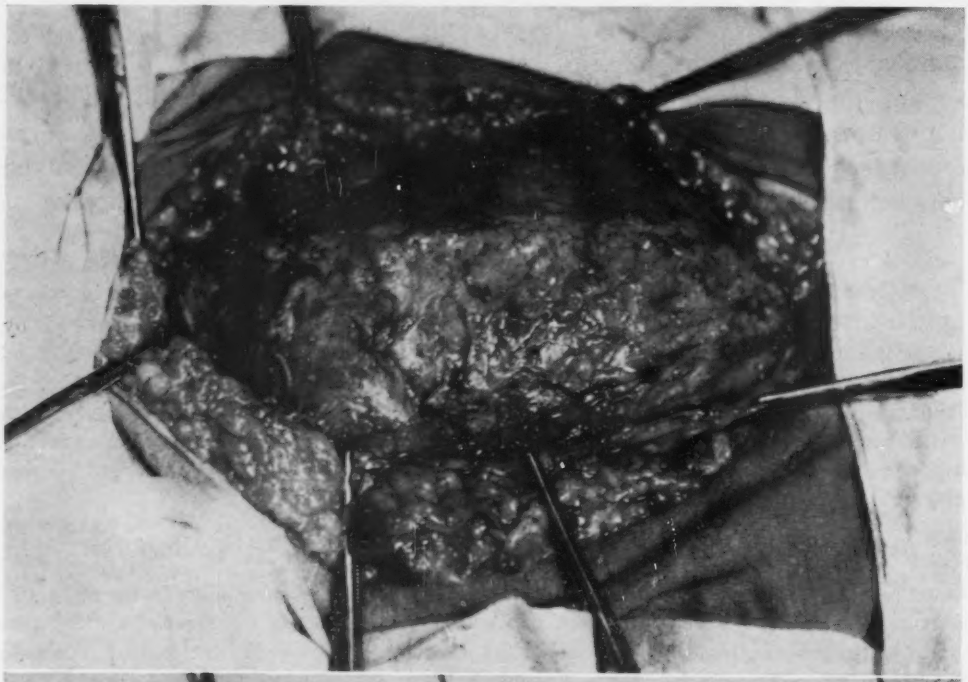


Fig. 8.

Fig. 7 (Case 4).—Large incisional hernial sac with wide separation of fascial margins.
Fig. 8 (Case 4).—Skin graft sutured to anterior surface of fascia. Note: Black cotton sutures were used for better photographic demonstration.

and the edges were closed by overlapping. Closure was difficult because of the wide separation of muscle and fascia. However, approximation was accomplished by use of No. 20 interrupted cotton sutures. The previously prepared skin transplant was sutured under tension to the anterior layer of fascia well away from the edge of the wound. A split rubber tube drain was inserted and the wound was closed. The drain was removed in forty-eight hours. The draining site closed promptly without further discharge. The man reports that on a recent examination by his family physician no weakness could be found at the operative site.

Fig. 9 (Case 4).—The right rectus scar is the site of hernia repair shown in Figs. 7 and 8. Lower scar is site of exit of gunshot wound.

Note.—This case demonstrates the ease with which a large defect of the abdominal wall can be reinforced with full-thickness skin.

CASE 5.—H. F. was operated on March 24, 1947, for removal of a tumor of the abdominal wall. She had been treated for squamous cell carcinoma of the cervical stump by means of radium, in the years 1938 and 1939. On April 6, 1939, a right oophorectomy was done for a papillary adenocarcinoma. On July 25, 1940, the left ovary was removed for the same disease. Late in 1946 a firm mass developed in the lower abdominal wall. This tumor increased in size and caused increasing discomfort. Therefore, she was again operated on March 24, 1947. A firm, well-encapsulated extraperitoneal tumor was found at the level of the rectus muscle, measuring 5 by 5 by 6 cm. It was resected along with surrounding muscle, peritoneum, and fascia. The abdomen and pelvis revealed no recurrence. Pathologic examination at the time of operation verified the recurrence of the original ovarian tumor. The abdomen was closed with difficulty; the previously excised skin was used to reinforce the closure. The wound healed despite much serous drainage. The woman has a firm abdominal wall at this time with no evidence of further recurrence of the original tumor.

Note.—Drainage can probably be explained on the basis of wide dissection of a very obese abdominal wall.

SUMMARY AND CONCLUSION

Investigations on the fate of full-thickness skin grafts in hernial repair in experimental dogs and rabbits verify the work done by others. Although certain epithelial elements disappear slowly, retention of these elements seems not to be a complicating factor.

Five human cases, followed postoperatively for eighteen to thirty-six months with good results, are reported.

Adequate tension upon the sutured skin seems to be the essential factor in bringing about the desired change.

Cotton sutures were used entirely in the cases reported, and appear to be a satisfactory suture material. Although Mair[1] used catgut exclusively, nonabsorbable sutures are not contraindicated.

Buried full-thickness skin has a definite place in hernial repair, particularly in large ventral hernia in obese patients.

REFERENCES

1. Mair, George B.: Preliminary Report on the Use of Whole Skin Grafts as a Substitute for Fascial Sutures in the Treatment of Herniae, Brit. J. Surg. **32**: 381, 1945.
2. Goodall, R. G., and Guthrie, R. F.: Repair With Whole Skin Grafts, South. Surgeon **13**: 135, 1947.
3. Peer, L. A., and Paddock, Royce: Histologic Studies on the Fate of Deeply Implanted Dermal Grafts: Observations on Sections of Implants Buried From One Week to One Year, Arch. Surg. **34**: 268, 1937.
4. Burdick, C. G., Gillespie, D. H. M., and Higenbotham, N. L.: Fascial Suture Operations for Hernia, Ann. Surg. **106**: 333, 1937.
5. Cannaday, J. E.: Use of the Cutis Graft in the Repair of Certain Types of Incisional Herniae and Other Conditions, Ann. Surg. **115**: 775, 1942.
6. Rehn, E.: München. med. Wchnschr. **61**: 118, 1914.
7. Harkins, H. N.: Cutis Grafts, Ann. Surg. **122**: 996, 1945.
8. Uihlein, A., Jr.: Use of Cutis Grafts in Plastic Operations, Arch. Surg. **38**: 118, 1939.
9. Schwartz, E.: Cited by Uihlein, ibid. p. 119.
10. Zimches, J. L.: Fate of Surface Epithelium Transplanted Into Deeper Tissues and Its Relation to Epithelial Cysts, Frankfurt. Ztschr. f. Path. **42**: 203, 1931.
11. Cannaday, J. E.: Some of the Uses of Cutis Grafts in Surgery, Am. J. Surg. **59**: 409, 1943.
12. Cannaday, J. E.: Additional Report on Uses of Cutis Grafts Material in Reparative Surgery, Am. J. Surg. **67**: 382, 1945.

GYNECOMASTIA IN CIRRHOSIS OF THE LIVER

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THE problem of gynecomastia frequently comes to the attention of surgeons because the only satisfactory treatment is removal of the affected breast. Surgery is indicated for the emotional disturbances caused by large breasts, for pain, to prevent injury or irritation, and because of the possibility that the lesion is malignant. Since one of us (W.B.B.) has seen fourteen examples of gynecomastia complicating cirrhosis of the liver during the past year, it is timely to emphasize the relationship of the lesion to chronic disease of the liver so that this possibility will be kept in mind.

Gynecomastia was not described as a complication of cirrhosis by Laennec, Bright, or Rolleston. Silvestrini[10] was apparently the first clinician to record the association and, in addition to gynecomastia, Corda[2] found atrophy of the testes in cirrhosis. In European writings the combination has been called the Silvestrini-Corda syndrome. The possibility that these and other endocrine disorders in cirrhosis resulted from a failure of the liver to inactivate estrogenic hormones was advanced by Edmondson, Glass, and Soll,[4] who demonstrated large amounts of free and small amounts of conjugated estrogens in the urine of eight men with gynecomastia and cirrhosis. It has been shown that gynecomastia may be produced in men without liver disease by natural estrogens or by stilbestrol.[3] There have been recent reviews dealing with the histopathology[5] and some of the endocrine aspects of this phenomenon.[1] The extensive endocrine relationships in chronic hepatic disorders have been summarized by Lloyd and Williams[8] who added their systematic observations upon patients with cirrhosis with emphasis on a decrease in libido, decrease in body hair, and a high frequency of testicular atrophy and of gynecomastia. Two illustrative cases follow.

CASE REPORTS

CASE 1.—F. B., a 66-year-old divorced cabinetmaker, was admitted to the Surgical Service of the Cincinnati General Hospital on Oct. 24, 1946, with swelling of the left breast of one month's duration.

Past History.—The pertinent facts revealed a story of moderate alcoholism and a very inadequate diet. Twelve years previously he had been operated on for a ruptured appendix. Four years before the present admission he noted exertional dyspnea, mild attacks of precordial pain, frequent nosebleeds, and was found to have hypertension. One year later he was hospitalized for hematemesis. The cause for this was not discovered at that time. One year later he was treated for pneumonia with sulfamerazine and made an uneventful recovery.

Family History.—His mother died of cirrhosis at the age of 82 years.

Physical Examination.—The blood pressure was 200/110 mm. Hg and the heart was slightly enlarged to the left. The liver was palpable 4 cm. below the costal margin. The edge was firm and smooth. There were no vascular spiders or palmar erythema. Hair distribution and genitals presented no abnormality. The left breast was diffusely enlarged and there was a small nodule just under the areola.

Operation.—Anesthesia was obtained by the local infiltration of 1 per cent procaine solution. An elliptical incision was made about the areola and the entire left breast excised down to the pectoral fascia. Microscopic examination of frozen sections of the firm, white,

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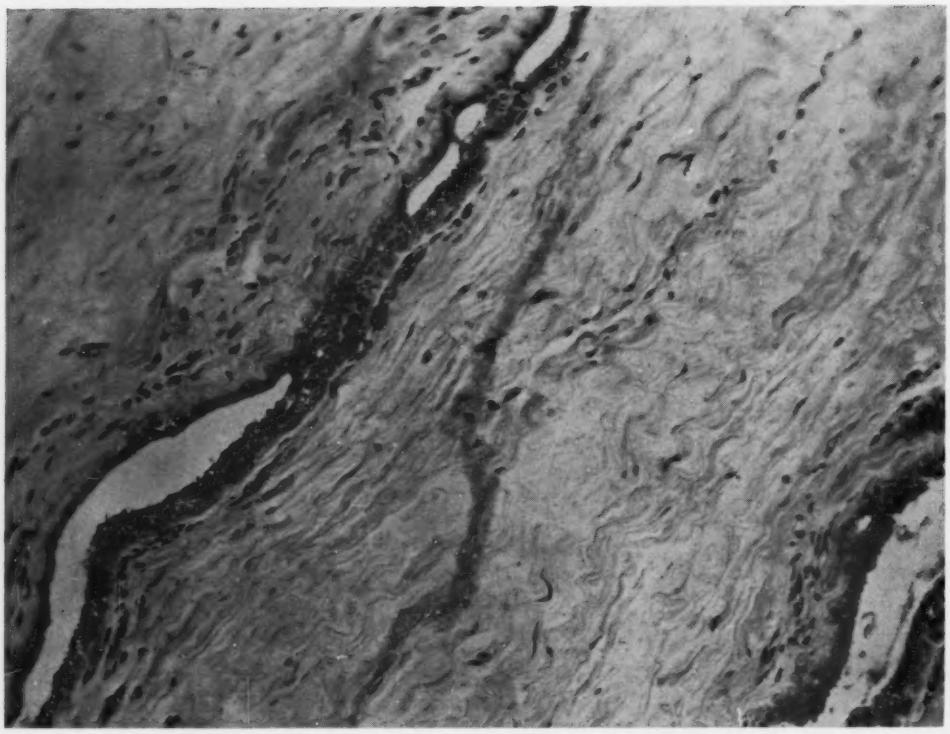

Fig. 1.—Normal male breast. The fibrous tissue stroma is dense and collagenous. There is no edema and no separation of the fibrils in the regions adjacent to the ducts. There is virtually no periductal infiltration of mononuclear cells. The ducts are straight and relatively small in caliber. They are lined by a double row of low columnar cells. No evidence of branching of the ducts is seen (magnification ×160).

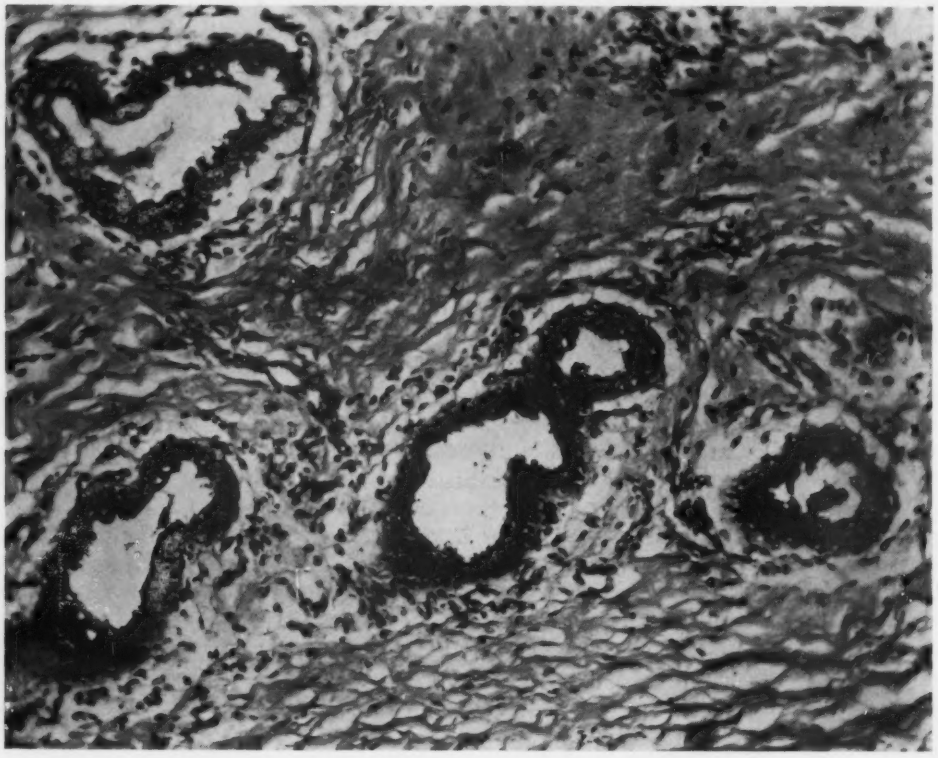

Fig. 2 (Case 1).—Gynecomastia. The particularly striking change from normal in this section is the looseness and increased cellularity of the periductal stroma. The diameter of the ducts is increased, they are more numerous, and they have branches (magnification ×160).

palpably nodular tissue showed no evidence of malignancy. The wound was closed in layers with interrupted sutures of fine silk.

Follow-up.—Convalescence was uneventful. On April 5, 1947, he was readmitted to the Medical Service for investigation of increasing dyspnea and upper abdominal pain. At that time it was found that he had developed bilateral palmar erythema and splenomegaly, and that the liver had become larger so that its edge was 8 cm. below the right costal margin. In view of these findings it was believed that he had hepatic cirrhosis of the Laennec type.

In the past year there has been no appreciable change in his status. In February, 1948, he had an anal fistula excised, and in July, 1948, was again in the hospital with bronchopneumonia. There has been no palpable abnormality of the remaining breast.

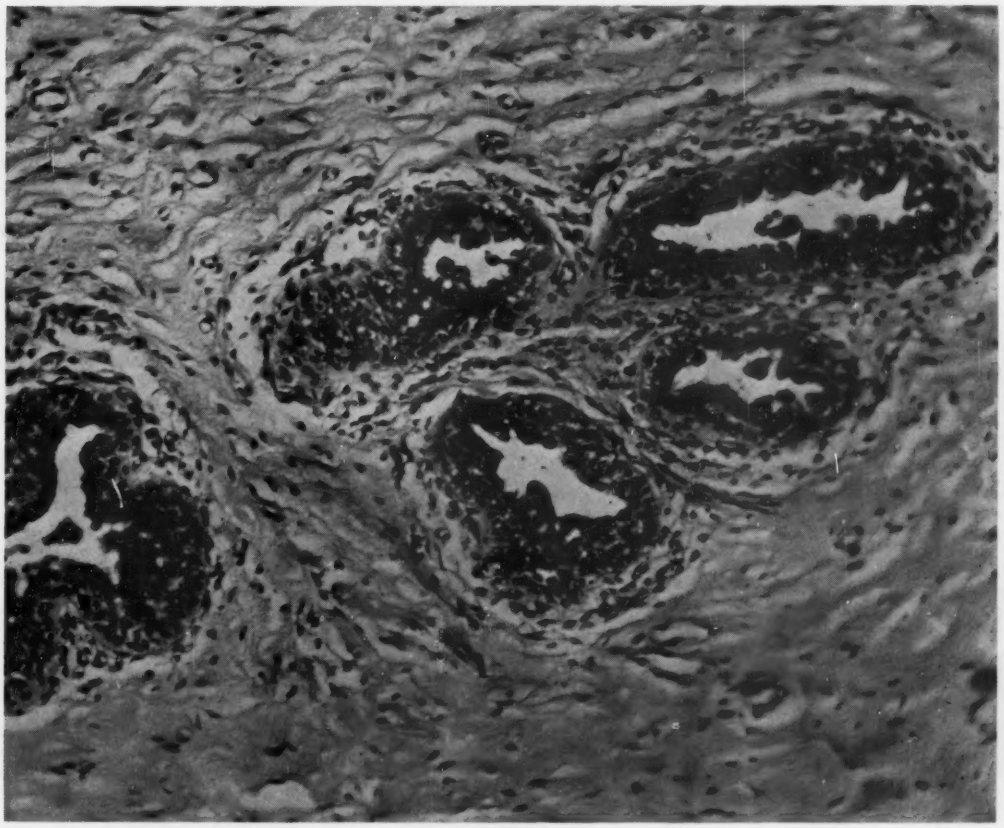

Fig. 3 (Case 2).—Gynecomastia. In this section the epithelial proliferation is conspicuous. The irregularity of the cell layers, plication of the lining, and epithelial projections into the lumens are all manifestations of the cellular activity. The periductal infiltration with mononuclear cells is well shown (magnification ×160).

CASE 2.—J. B., a 74-year-old white married man, was admitted to the Surgical Service of the Cincinnati General Hospital on Oct. 21, 1946, because of a mass under the nipple of the left breast.

Past History.—There was a history of inflammatory rheumatism at the age of 6 years; a chancre at the age of 26 years, with inadequate treatment; and a transitory hemiplegia one year later. He had been a moderate drinker. Four years before admission he had exertional dyspnea, orthopnea, and some retrosternal pain on exertion. He was treated for heart failure with digitalis and was given a course of bismuth. In July, 1945, the diagnosis of aortic stenosis was made. At this time he had ascites, an enlarged liver and spleen, and palmar erythema.

Physical Examination.—Physical examination revealed a quarrelsome old man with moderate kyphosis and emphysema. Blood pressure was 170/60. There were typical signs of

aortic stenosis including thrill, a harsh systolic murmur transmitted to the neck, softer diastolic murmur, and enlargement of the heart to the left. The liver was palpable three fingerbreadths below the rib margin and the spleen was felt readily. There was a small amount of fluid in the abdomen and slight edema of the ankles. There was no alopecia or testicular atrophy but moderate hypertrophy of the prostate was found. Immediately underlying the nipple of the left breast, attached to the skin but freely movable over the deeper tissues, there was a firm, rubbery, non-tender mass the size of a walnut. There was no discharge. The patient had bilateral palmar erythema but no vascular spiders.

Operation.—Anesthesia was obtained by the local infiltration of ½ per cent procaine solution. Through an elliptical incision about the areola, the entire left breast was excised down to the pectoral fascia. On section the excised breast tissue was pearly white, firm, and homogeneous except for scattered cystic areas each of which was about 1 cm. in diameter. Histologic examination of frozen sections showed no evidence of malignancy. The wound was closed in layers with interrupted sutures of fine silk.

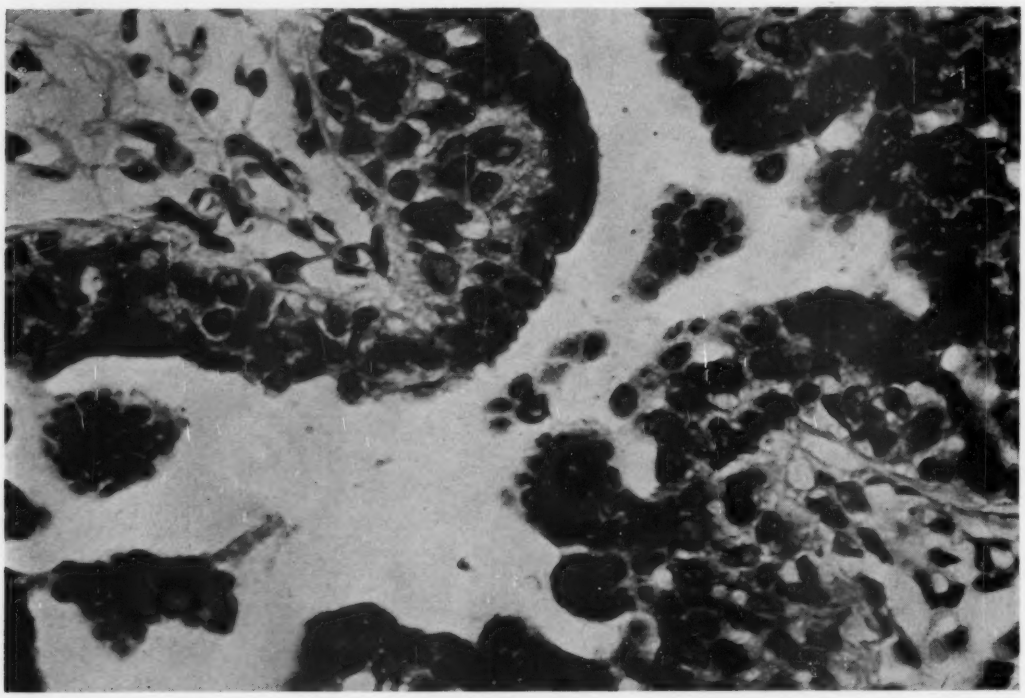

Fig. 4.—A high power magnification (×650) of a portion of Fig. 3 demonstrates the epithelial proliferation.

Subsequent Course.—Following the uneventful healing of the wound the patient was observed in the medical and surgical clinics. He was readmitted to the Medical Service on March 17, 1947, because of increase in the ascites and a moderate diarrhea. He had a paracentesis with removal of 1,700 c.c. of fluid. There was some dyspnea but he was progressing well until the eleventh hospital day when he had a series of attacks of substernal pain, passed a tarry stool, went into shock, and died in spite of transfusions of blood and plasma.

Necropsy.—The main findings were those of hepatic cirrhosis with erosion of a varix of the esophagus, with old blood in the stomach and small and large intestines. There was mitral stenosis and advanced stenosis of the aortic valve resulting from calcification. The brain showed areas of softening and moderate sclerosis of cerebral arteries. Unfortunately the remaining breast was not examined.

DISCUSSION

We have presented notes on the clinical findings in two cases of gynecomastia complicating cirrhosis of the liver. There is evidence that in chronic

disease of the liver the estrogenic hormones may not be inactivated, destroyed, or excreted in normal fashion.[1, 4, 8] The histologic picture found in the breasts which we have excised include (1) epithelial proliferation resulting in the piling up of cells and their projection into the lumens of the ducts in the form of pseudo-papillae (Fig. 4); (2) multiplication of ducts with an increase in diameter, occurrence of tortuosity, and formation of branches (Figs. 2 and 3); (3) change in the character of the periductal connective tissue which is looser in structure and more cellular than the stroma of the remainder of the breast; and (4) the appearance of relatively large numbers of mononuclear cells, chiefly lymphocytes and macrophages with a few plasma cells in the periductal regions. These changes are generally recognized as resulting from estrogenic activity.[5] There are no signs of progesterone effect such as the formation of lobules and acini.

It may be surprising that this type of gynecomastia, which is most likely a result of hormonal forces thrown into imbalance by failure of proper liver function, produces a change confined to or affecting disproportionately only one breast. This, however, is the usual finding.[6] Parkes-Weber[9] discussed this phenomenon in an interesting paper. There is nothing to suggest that the type of gynecomastia under discussion belongs in the syndrome described by Klinefelter and colleagues.[7]

We are recording here two instances of unilateral gynecomastia in association with chronic disease of the liver. The purpose of this report is to emphasize the fact that the presence of gynecomastia should direct attention to the possibility of Laennec's cirrhosis or some other form of chronic disease of the liver. The cirrhosis rather than the change in the breast is usually the important problem for attention as far as the patient's welfare is concerned.

SUMMARY AND CONCLUSIONS

1. Two patients with gynecomastia complicating chronic hepatic disease are reported.

2. The histologic changes found in the breasts were compatible with those produced by estrogenic hormones.

3. The finding of gynecomastia should direct attention to the possibility of chronic disease of the liver and appropriate steps should be made to detect and treat it if it is present.

REFERENCES

1. Bean, W. B.: The Cutaneous Arterial Spider; a Survey, Medicine **24**: 243, 1945.
2. Corda, L.: Sulla c. d. revivicenza della mammella maschile nella cirrosi epatica, Minerva Med. **5**: 1067, 1925.
3. Dunn, C. W.: Stilbestrol-induced Gynecomastia in the Male, J. A. M. A. **115**: 2263, 1940.
4. Edmondson, H. A., Glass, S. J., and Soll, S. N.: Gynecomastia Associated With Cirrhosis of the Liver, Proc. Soc. Exper. Biol. & Med. **42**: 97, 1939.
5. Geschichter, C. F.: Diseases of the Breast, Philadelphia, 1943, J. B. Lippincott Company.
6. Karsner, H. T.: Gynecomastia, Am. J. Path. **22**: 235, 1946.
7. Klinefelter, H. F., Reifenstein, E. C., Jr., and Albright, F.: Syndrome Characterized by Gynecomastia, Aspermatogenesis Without a-Leydigism, and Increased Excretion of Follicle-stimulating Hormone, J. Clin. Endocrinol. **2**: 615, 1942.
8. Lloyd, C. W., and Williams, R. A.: Endocrine Changes Associated With Laennec's Cirrhosis of the Liver, Am. J. Med. **4**: 315, 1948.
9. Parkes-Weber, F.: Gynecomastia and Asymmetrical Action of Hormones, Lancet **1**: 446, 1943.
10. Silvestrini, R.: La reviviscenza mammaria vell 'como affetto da cirrosi del Laennec, Riforma med. **42**: 701, 1926.

CONGENITAL ABSENCE OF THE GALL BLADDER

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THE gall bladder, as illustrated in Fig. 1, arises from the hepatic diverticulum which, according to Arey,[1] arises from the gut entoderm in the region of the floor of the future duodenum. In the 3 mm. embryo it consists of a hollow sacculation. Its cranial portion forms the liver and bile ducts and its caudal portion the gall bladder and cystic duct. In the 5 mm. human embryo, this caudal portion has formed into a solid cylinder which, by vacuolization again develops a lumen by the end of the 15 mm. stage. Bile is secreted in fetuses about 3 months old. Krafka[2] stated that the gall bladder and cystic duct are originally midline structures. Early they may be deeply embedded in substance of the liver, reaching a superficial position by the end of the third month.

According to Gorham and Ivy[3] the gall bladder is a typical vertebrate and primitive mammalian structure and is not easily lost. It is present in all carnivores with the exception of the whale, in all reptiles, and amphibians. Its presence is variable in Herbivora and birds. Mentzer[4] listed seventeen species of fish, nine of birds, and twenty-six mammals that are normally devoid of a gall bladder. Its frequent individual absence suggests that it is in the process of being lost in some species, for example, the giraffe. Absence of the gall bladder associated with dilatation of the distal common duct normally occurs in the seal, otter, walrus, and elephant. Some species, for example, the pigeon, develop an embryonal gall bladder which later disappears. In many reptiles and most marsupials the gall bladder is more or less embedded in the substance of the liver and other variations in position occur in other species.

Absence of the gall bladder in man is an uncommon entity. Most cases have associated defects of the biliary ductal system. About one-sixth of reported cases of congenital biliary tract atresia are associated with gall bladder absence.[5] Tallmadge[6] found gall bladder absence to occur in 12 of 18,350 collected autopsy cases, an incidence of .065 per cent. Other autopsy series give a similar incidence with the exception of the London Hospital for Sick Children, quoted by Stolkind[7] as reporting an incidence of 20 in 5,395 autopsy cases. Undoubtedly many of these possessed other biliary or extrabiliary associated anomalies.

Congenital absence of the gall bladder unassociated with other anomalies of the biliary tract is extremely rare. Recent studies of collected cases of gall bladder absence have been carried out by Gross,[5] Dixon,[8] Stolkind,[7] and Latimer.[9] About 75 cases of definite isolated gall bladder absence have been recorded to date. About one-half of these were discovered at operation and

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half at autopsy. The sex incidence was equal in autopsied cases but females predominated by a 3-to-1 ratio in the cases in which operation was done. The average age at discovery was 46 years.[8, 9] The majority of cases in younger individuals were found incidentally at autopsy and the majority in older individuals were found at laparotomy. In most cases the gall bladder fossa was absent or shallow and the cystic duct was absent. In some cases a fibrous cord was found at the expected site of the gall bladder or cystic duct. Cases of rudimentary gall bladder have not been included in this discussion.

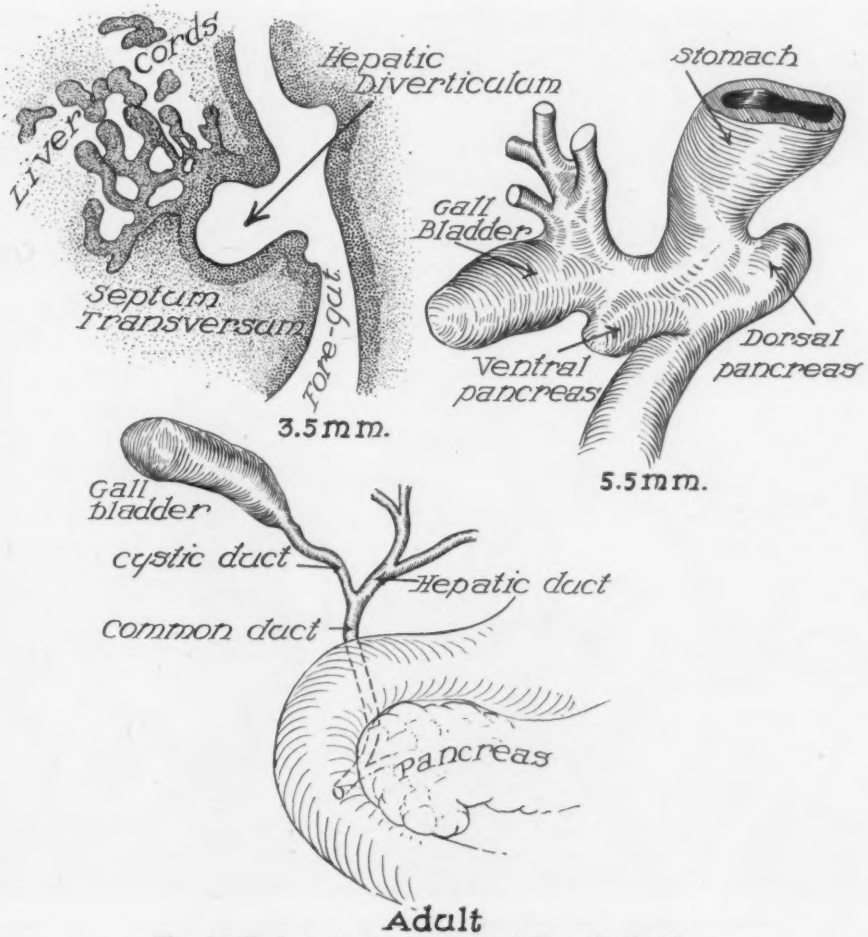

Fig. 1.—Embryonic development of the gall bladder.

In Dixon's[8] series of collected and added cases, 73 per cent of those patients over 45 years of age complained of symptoms resembling those of cholecystic disease. In twenty-four of the thirty-four laparotomized patients, the preoperative diagnosis was that of cholecystic disease. Common duct stone was present in two-thirds of those patients who were operated on because of symptoms and physical findings suggestive of cholecystic or choledochal disease. Most of these had a history of past jaundice or were jaundiced at the time of operation.

The absence of a gall bladder shadow on roentgenologic examination may be misinterpreted as representing a pathologic nonfunctioning gall bladder. On the other hand, roentgenology may serve to visualize an abnormally placed gall bladder. The gall bladder, according to Gross[5] and Otis,[10] may be partially or, more rarely, completely enclosed by the substance of the liver. In some of the latter cases, a bulge on the liver surface is discernible. It may

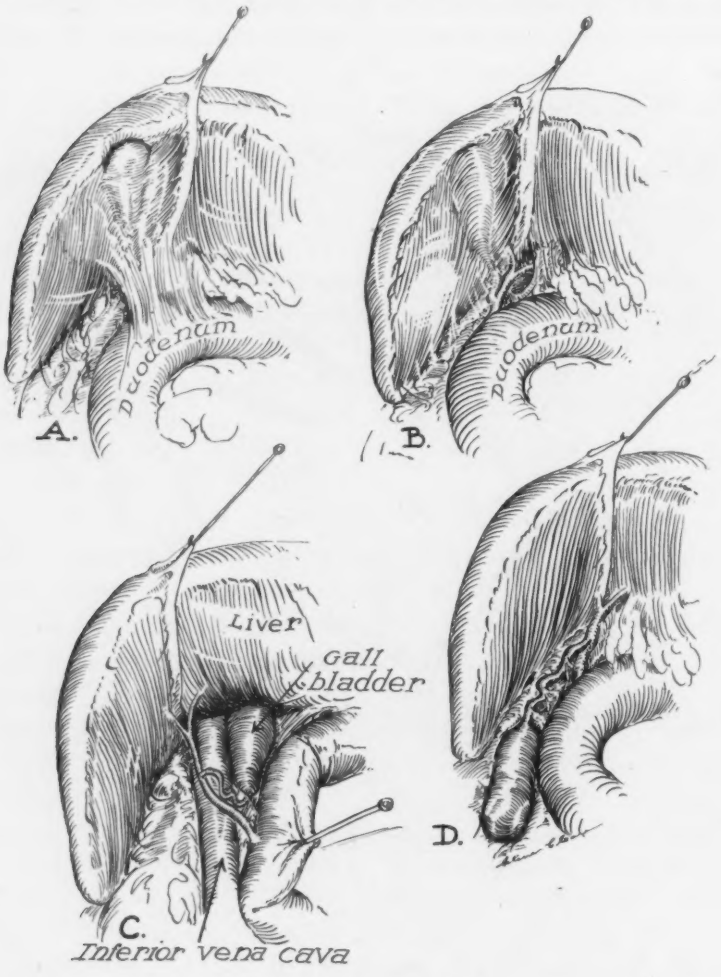

Fig. 2.—More common malpositions of the gall bladder. *A*, Partially intrahepatic; *B*, completely intrahepatic; *C*, in retroperitoneal space; *D*, mobile gall bladder with long mesentery.

also be located on the undersurface of the left lobe of the liver, on the posterior surface of the liver, or in a retroperitoneal position adjacent to the vena cava. It may be freely suspended by a mesentery, a condition predisposing to torsion and infarction. Bullard[11] reported a case of a subcutaneous gall bladder. The more common malpositions are diagrammatically represented in Fig. 2.

The following case of complete congenital absence of the gall bladder was observed by us.

CASE REPORT

Mrs. H. H. B., aged 30 years, white woman, was admitted to the L. D. S. Hospital June 10, 1947 (Hospital No. 233374).

Principal Complaint.—This patient's principal complaint was that of epigastric pain and a feeling of fullness following meals, particularly severe after the injestion of fatty foods. The pain was associated with nausea but not vomiting. The postprandial discomfort had occurred persistently for two months prior to admission. The pain was described as severe and lasting from fifteen minutes to three hours. It did not radiate into the

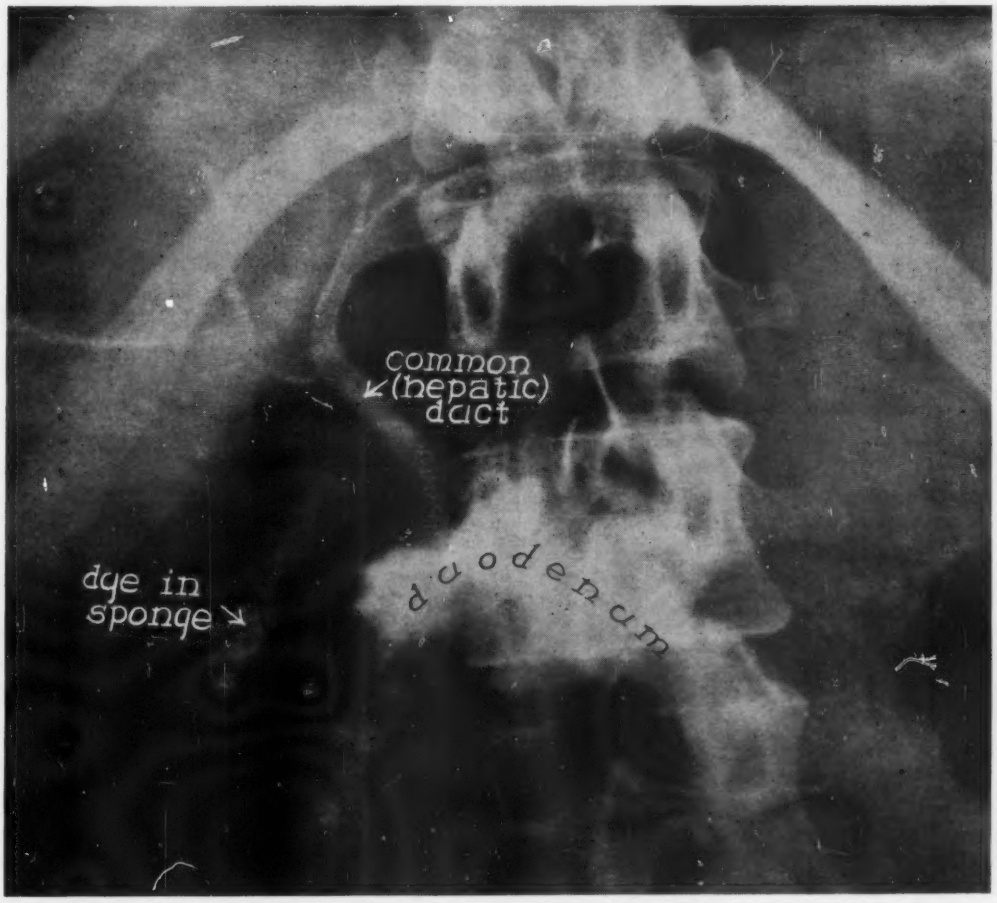

Fig. 3.—Cholangiogram at time of surgery (retouched).

back nor require morphine for relief. Physical examination revealed a moderate right subcostal tenderness and otherwise was essentially negative. No gall bladder shadow or x-ray evidence of stone was seen on roentgenologic examination. Temperature and white blood count were normal. The patient had similar symptoms and findings persisting over a period of several weeks in 1941. At that time the gall bladder also failed to visualize. Gastric analysis showed no free acid in the fasting specimen and 4° following installation of alcohol. White blood count and measures of hemoglobin concentration were normal. She was placed on a fat-free diet and remained relatively symptom-free except after indulging in rich or fatty foods. She gave no history of jaundice at any time.

This patient had been seen at intervals at the Inter-Mountain Clinic for routine examinations and minor illnesses since 1927. In 1928 she underwent an appendectomy. The

appendix showed gross and microscopic evidence of acute inflammation. Preoperative diagnosis at the time of the present admission was chronic cholecystitis with possible cholelithiasis.

The patient was operated upon by one of us (F. F. H.) under procaine block and light pentothal cyclopropane anesthesia on June 11, 1947. The duodenum and transverse colon were found to be adherent to the liver margin. These were dissected free and the gall bladder area was carefully explored down to the common duct. No evidence of a gall bladder, cystic duct, or gall bladder fossa was found. The common hepatic duct was dissected free and inspected from the posterior aspect of the duodenum to its bifurcation into right and left hepatic ducts. It was normal in size and position and contained no evidence of stone. The foramen of Winslow was patent. The gastrohepatic ligament and contained structures were carefully palpated as were the inferoposterior surface of the liver, the duodenum, pancreas, stomach, and right side of the colon. No evidence of a gall bladder or cystic duct or artery and no other pathology except a few nonconstricting adhesions in the ileocecal region was found.

The accessible upper retroperitoneal space was palpated and no abnormal structures were felt. The common hepatic duct was aspirated through a small needle and normal-appearing bile was obtained. Through the same needle 30 c.c. of 35 per cent diodrast was injected and a choledochogram was made. The extrahepatic bile ducts filled partially as did portions of the intrahepatic ducts (Fig. 3). Most of the dye was observed to be present in the region of the duodenum. No intrahepatic gall bladder was revealed by this procedure. A Penrose drain was placed to the site of the common duct puncture and the abdominal wall was closed in layers with interrupted cotton sutures. The postoperative convalescence was uneventful. A small amount of bile drainage persisted for six days. The patient was ambulated early and discharged on the tenth postoperative day.

Postoperatively she complained of some moderate epigastric discomfort after meals for three weeks. She has had no discomfort since except after ingestion of fatty foods. She has subsequently gone through a normal pregnancy and delivery. One month after surgery a gastrointestinal x-ray series revealed a small duodenal ulcer crater. She was placed on an ulcer regime which she followed for a few weeks only and has failed to return for gastrointestinal follow-up study.

DISCUSSION

Congenital absence of the gall bladder may be due to agenesis, to developmental arrest at the prevacuolization stage, or to subsequent fetal involution. The occurrence of a rudimentary gall bladder, residual histologic evidence of the organ, or evidence of past severe inflammation in the region of the hepatic fossa may, in certain instances, represent the result of severe necrotizing infection. Such cases have not been included in this report. The fact that the gall bladder is, for a time during its development, located in the hepatic substance gives an embryologic explanation of the occasional find of an intrahepatic gall bladder and points toward the importance of trying to rule out this anomaly in cases with suspected gall bladder absence. The fact that the great majority of cases of gall bladder absence are associated with other biliary tract anomalies correlates with the common cellular origin of these structures and supports the theory of agenesis or aplasia. That absence of the gall bladder and abnormal position of the organ have their normal anatomic counterpart in certain lower species emphasizes the phylogenetic factor in the development of such anomalies.

Functions commonly ascribed to the human gall bladder include the storage and concentration of bile and the decrease of bile alkalinity. It is also credited with helping to maintain a more constant biliary tract pressure. A competent sphincter of Oddi is essential for gall bladder filling. Emptying of the gall bladder is primarily dependent on contraction of the organ, plus concomitant re-

laxation of the sphincter of Oddi and periductal duodenal musculature. Emptying is under autonomic nervous system and hormonal control.

From studies of the comparative anatomy of the biliary tract, Gorham and Ivy[3] attempted to correlate gall bladder function with its evolution. They concluded that the gall bladder is fundamentally stable and adapts much more slowly, from an evolutionary standpoint, to changes in dietary habit than does the remainder of the gastrointestinal tract. The Carnivora habitually ingest at one meal large quantities of food containing considerable fat. The interval between their meals is often long and irregular. They consequently require an organ that will effectively concentrate large quantities of bile and store it for prolonged periods; such an organ they possess. Conversely, the Herbivora do not require an inconstant flow on concentrated bile; they possess either no gall bladder or one with poor powers of concentration and retention. It is of interest that acholecystic species possess mechanisms that tend to prevent biliary stasis and regurgitation. These mechanisms include the secretion of large amounts of bile and the possession of a competent valve or valves in the distal portion of the common duct. (The common duct in acholecystic individuals is technically the common hepatic duct.) The ejaculatory discharge of bile in animals possessing a gall bladder contrasted with the dribbling type of discharge in acholecystic species points to a difference in their sphincter action.

Barnstorf's[12] review of collected cases of congenital absence of the gall bladder revealed that the common hepatic duct and its branches are very rarely dilated unless ductal stones are present. Thus, in man, the common hepatic duct does not appear to attempt to compensate by dilatation for the absence of the gall bladder. Common duct dilatation, however, commonly occurs after cholecystectomy. The failure of occurrence of common duct dilatation in uncomplicated congenitally acholecystic patients as compared to its frequent dilatation following cholecystectomy suggests some difference in mechanism of action in the sphincter of Oddi, ductal musculature, or periductal duodenal musculature in these two similar conditions. The cause of common duct dilatation following cholecystectomy, except in cases having common duct stones, remains unexplained. The most apparent explanation is that it is due to an increased tonicity of the sphincter of Oddi associated with loss of the bile-concentrating mechanism. Puestow,[13] however, measured T-tube pressures for several months following cholecystectomy in a significant number of cases and found the pressure to be consistently low. From this he concluded that persistent relaxation of the sphincter of Oddi occurs after cholecystectomy. That persistent relaxation of the sphincter of Oddi does not cause common duct dilatation is supported by the usually normal size of the duct in species with congenital gall bladder absence and demonstrated sphincter atonicity. By inference, such atonicity is also present in the congenitally acholecystic human being. We suggest that postcholecystectomy common duct dilatation may be caused by an active dilatation due to created autonomic imbalance similar, perhaps, to the mechanism causing achalasia of the esophagus described by Ochsner and DeBakey.[14] Degenerative lesions of the autonomic nerves have been described by Womack[15] in patients with the post-cholecystectomy syndrome.

The fact that, in the group under 45 years of age, congenital absence of the gall bladder was usually a necropsy or incidental laparotomy finding suggests that such absence, per se, causes no symptoms. The high incidence of symptoms of cholecystitis in the older age group re-emphasizes the fact that the symptoms of cholecystitis may be the symptoms of biliary tract disease and that cholecystic disease is often merely a component part of biliary tract disease. The cause of symptoms of cholecystitis in the group in which no ductal or extraductal pathology was found is as obscure as the cause of symptoms in many cases of biliary dyskinesia. It is possible that in some an undiagnosed misplaced gall bladder or pancreatitis exists. Dixon[8] favors prolonged T-tube drainage in such cases.

The relatively high incidence of common hepatic duct stones (sixteen of sixty collected cases) found in congenitally acholecystic cases is striking. That they occur much more commonly than in patients possessing a gall bladder points to the probable importance of that organ, when functioning normally, in preventing ductal stone formation. Such argument is sustained by the fact that the gall bladder decreases the alkalinity of bile, increases bile flow by the discharge of its so-called "ignition" bile into the duodenum, and perhaps helps maintain a more constant biliary tract pressure, thereby minimizing regurgitation of duodenal content into the biliary tree.

The diagnosis of congenital absence of the gall bladder has not been made preoperatively. Failure to find a gall bladder in its expected location at laparotomy in a patient with symptoms of cholecystitis makes mandatory (1) a thorough examination of the biliary system in search for the organ and (2) careful examination of adjacent viscera, disease of which may produce similar symptoms. Careful dissection of the hepatic ducts may reveal a cystic duct which can be followed to a misplaced gall bladder. Palpation and inspection of the surface of the liver may reveal a bulge created by an intrahepatic gall bladder. Needling of the liver is of questionable value as bile may be aspirated from a dilated bile duct. Robertson[16] reported a persistent biliary fistula following this procedure. The injection of a radiopaque substance into the common duct either at the time of surgery or through a T tube or catheter following surgery would appear to be an aid in locating an abnormally placed gall bladder whose cystic duct communicates with the common or hepatic ducts. Although this has been done in a few cases of suspected gall bladder absence, we find no record of a misplaced organ having been visualized by this means. In our case, the injected Diodrast rapidly escaped into the duodenum. This is the expected result if the sphincter of Oddi is atonic. A more satisfactory choledochogram could be obtained in these cases if the duct were constricted distal to the point of injection at the time of operation, thereby allowing the intraductal pressure to increase and better retrograde filling to occur. Inasmuch as the duodenum and pancreas have a cellular origin in common with the biliary tract, careful examination of these organs for associated defect should be carried out.

SUMMARY AND CONCLUSIONS

1. Isolated congenital absence of the gall bladder is a rare anomaly. One additional case is reported.

2. The occurrence of this anomaly may be explained on embryologic grounds. Gall bladder absence occurs normally in many species of fish, birds, and mammals. The gall bladder is, however, fundamentally stable and from an evolutionary standpoint adapts slowly to change in dietary habit. Correlation of gall bladder presence and efficiency of function with need for its function is observed. Various displacements of the organ in man have their normal anatomic counterpart in lower species.

3. The high incidence of extrahepatic duct stone in congenitally acholecystic man suggests the probable usefulness of the normally functioning gall bladder in preventing extrahepatic duct stone formation.

4. Failure to find a gall bladder in its normal position at operation makes mandatory a thorough search for an abnormally positioned gall bladder and for extrabiliary pathology.

5. Dilation of the common duct occurs commonly following cholecystectomy but is rarely seen in uncomplicated congenitally acholecystic individuals. The etiologic factors are discussed and a theory of active common duct dilatation in the cholecystectomized group is postulated.

6. The use of the cholangiogram in ruling out an abnormally placed gall bladder is discussed. In view of a probable atonic sphincter of Oddi in congenitally acholecystic cases, it is suggested that the procedure be done at the time of operation and that the duct be compressed distal to the point of injection of the Diodrast.

REFERENCES

1. Arey, L. B.: Developmental Anatomy, a Textbook and Laboratory Manual of Embryology, Philadelphia, 1940, W. B. Saunders Company.
2. Krafka, Joseph, Jr.: Human Embryology, New York, 1942, Paul B. Hoeber, Inc.
3. Gorham, F., and Ivy, A. C.: Evolutionary Contributions to the General Function of the Gall Bladder, Am. J. Digest. Dis. & Nutrition **4**: 722, 1938.
4. Mentzer, S. H.: Anomalous Bile Ducts in Man—Based on a Study of Comparative Anatomy, J. A. M. A. **93**: 1273, 1929.
5. Gross, R. E.: Congenital Anomalies of the Gall Bladder—A Review of 148 Cases and Report of a Double Gall Bladder, Arch. Surg. **32**: 131, 1936.
6. Tallmadge, G. K.: Congenital Absence of the Gall Bladder, Arch. Path. **26**: 1060, 1938.
7. Stolkind, E.: Congenital Abnormalities of the Gall Bladder and Extrahepatic Ducts—Review of 245 Reported Cases With Reports of 31 Unpublished Cases Brit. J. Child. Dis. **36**: 115, 182, 1939.
8. Dixon, C. F., and Lichtman, A. L.: Congenital Absence of the Gall Bladder, SURGERY **17**: 11, 1945.
9. Latimer, E. O., Mendez, F. L., Jr., and Hage, W. J.: Congenital Absence of the Gall Bladder—Report of 3 Cases, Ann. Surg. **126**: 229, 1947.
10. Otis, W. M., and Neiman, Aaron: Case Report of an Intrahepatic Gall Bladder in an Adult—With a Review of the Literature, Illinois M. J. **60**: 478, 1931.
11. Bullard, R. W., Jr.: Subcutaneous or Extraperitoneal Gall Bladder—Report of Unusual Case, J. A. M. A. **129**: 949, 1945.
12. Barnstorf, F.: Zur Agenesie der Gallenblase, Frankfurt. Ztschr. f. Path. **42**: 304, 1931.
13. Puestow, C. B.: Changes in Intracholedochal Pressure Following Cholecystectomy, Surg., Gynec. & Obst. **67**: 82, 1938.
14. Ochsner, A., and DeBakey, M.: Surgical Considerations of Achalasia, A Review of the Literature and Report of Three Cases, Arch. Surg. **41**: 1146, 1940.
15. Womack, N. A., and Cuder, R. L.: The Persistence of Symptoms Following Cholecystectomy, Ann. Surg. **126**: 31, 1947.
16. Robertson, H. F., Robertson, W. E., and Bower, J. C.: Congenital Absence of the Gall Bladder With Primary Carcinoma of the Common Duct and Carcinoma of the Liver, J. A. M. A. **114**: 1514, 1940.

INTESTINAL OBSTRUCTION CAUSED BY A GALLSTONE

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BLOCKAGE of the intestine by a gallstone may be one of the rare causes of obstruction (probably less than 1 per cent); yet it is a dramatic, amazing illustration of Nature's endeavor to expel a foreign body. Usually it is a single large stone and in one-half of such cases there are found no other gallstones, or else there have been small ones which have been expelled.

The surgeon not infrequently encounters an inflamed gall bladder, which has become adherent to an adjoining viscus, and in some instances has perforated into the viscus or into the peritoneal cavity. This type of complication is unlikely to cause obstruction other than that due to a localized inflammatory mass. Up to 1939, at the Mayo Clinic, Wakefield and associates[1] found records of 176 instances of fistulas from the gall bladder, but only 10 instances[2] of intestinal obstruction due to a gallstone. In these 10 cases, 7 patients underwent operation and recovered but 3 died of obstruction which, at necropsy, was found to be due to a gallstone in the lower portion of the ileum. Since 1939, 7 additional surgical cases and 1 case in which the obstruction was observed at necropsy‡ have been studied, making a total of 18 instances of obstruction due to a gallstone. All 7 surgical patients of this second group recovered. Table I is a composite of the data in the 18 cases.

The stone had burrowed from the gall bladder into the duodenum in all but one of these 18 cases, this being the case of obstruction in the colon as a result of a direct perforation from the gall bladder into the colon. It is very uncommon for a stone to pass down the small bowel and lodge in the colon. Harris and associates,[3] reporting on 4 cases of intestinal obstruction due to a gallstone, found that in 2 of their 4 cases, the stone had worked into the duodenum and had not lodged until it had reached the sigmoid. Quite naturally, in both of these cases the condition was considered, preoperatively, to be cancer.

Of even greater curiosity is intestinal obstruction due to two gallstones. Downing[4] has reported such a case, one of a group of 5 cases of obstruction due to a gallstone that he had encountered. In this instance, obstruction was temporarily relieved by removal of a stone from the mid-portion of the ileum but the obstruction recurred to such an extent that in ten days a second operation was undertaken. It was thought that this second obstruction was due to adhesions, but on the day after the second operation the patient spontaneously passed a large gallstone from the rectum. We know of one such instance.

This serious complication of cholecystic disease, as would be expected, occurs chiefly in women: 16 of these 18 patients were women. As to age, the

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‡This case was that of a woman 81 years of age. She had had symptoms of cholecystitis for some years. Ten days prior to admission, severe pain and persistent vomiting began. On admission she was irrational, weak, and dehydrated. Operation was not possible and she died on the eighth day in the hospital. Necropsy revealed a gallstone, 9 by 4 cm., which completely blocked the duodenum.

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TABLE I. INTESTINAL OBSTRUCTION DUE TO A GALLSTONE

NUMBER	SITE OF OBSTRUCTION	SYMPTOMS OF CHOLECYSTIC DISEASE	SYMPTOMS OF INTESTINAL OBSTRUCTION	ASSOCIATED BILIARY CALCULI
6	Duodenum	3 indefinite 3 definite	2 intermittent 4 steady	None in 5 Present in 1
1	Jejunum	Definite	Steady	None
10	Ileum	4 none 2 definite 4 indefinite	5 intermittent 5 steady	Present in 5 None in 5
1	Colon	Definite	Intermittent	Present

2 men were in the forties. One woman was 31 years of age; 3 each were in the forties and fifties; 4 each were in the sixties and seventies, and 1 was 81 years of age.

It is possible to illustrate a consecutive story of the progress of a stone from the gall bladder into and down the intestinal tract. Rupture of a diseased gall bladder, usually with stones, is not uncommon, but burrowing of a single large stone into the bowel presents the curious paradox of either prodromal symptoms and warnings of gall bladder disease or the onset of intestinal obstruction with the stone found lodged in the lower part of the ileum or even the sigmoid, all in the course of one or a series of attacks of obstruction. Such cases are not properly gallstone ileus but true obturator obstruction. An example of true gallstone ileus is given in Case 1.

REPORT OF CASES

CASE 1.—The patient, a man aged 38 years, was admitted to the clinic July 3, 1942. Appendectomy had been performed in 1934. Three years prior to admission, he had experienced recurring attacks of severe upper abdominal pains. These attacks came at any time but often during the night and usually if a heavy meal had been eaten in the evening. Between the acute attacks, he had noted intolerance to fatty foods. Four days prior to admission, he had been awakened early in the morning with a very severe attack of pain. Morphine had been required. He had had no bowel movement for two or three days prior to this attack. The pains continued and were intermittent and severe. There was nausea and vomiting. On July 2, the bowels did move well and freely.

Physical examination revealed that the abdomen was distended and tympanitic. Temperature was 100.2° F. and the pulse rate was 66. The leucocyte count was 11,000 per cubic millimeter of blood. A simple roentgenogram of the abdomen disclosed marked distention of the colon and small bowel. Intestinal intubation was established and fluids were administered intravenously. After twenty-four hours, there was no apparent decrease of the intestinal distention. On the third day after admission, the patient's general condition was quite satisfactory but the distention persisted, so that surgical intervention was undertaken with the preoperative diagnosis of obstruction in the distal portion of the ileum. Free fluid was present in the abdomen. The entire intestine was normal but the gall bladder was large, tense, acutely inflamed, and full of stones. The patient was dismissed from the hospital on the fourteenth postoperative day. When he was seen again five years later it was learned that he had had no further abdominal distress.

Comment.—This is a good illustration of intestinal ileus due to an acute inflammation of the gall bladder. The picture was that of pains and distention which certainly suggested intestinal blockage. With conservative measures of intestinal intubation, intravenous administration of fluids, and careful observation it was obvious that the condition was subsiding and likewise was surgical.

The antecedent history of dyspepsia and colics would afford a clue of gall bladder disease although the severity of this particular attack was such that the diagnosis of intestinal obstruction was dominant in the opinion of all who saw the patient. Such being the case, operation was undertaken rather than risk further medical treatment merely to establish a more accurate preoperative diagnosis.

Continuing from gallstone ileus to actual involvement of the bowel by the onset of a stone burrowing from the gall bladder into the bowel, the following instance affords a clear picture of what is in the making:

CASE 2.—The patient, a woman aged 54 years, was admitted to the clinic May 15, 1947. Since 1937, she had suffered from attacks of upper right abdominal pain which had slowly increased in severity. She had vague chronic dyspepsia. In 1941, a severe attack of pain had required care in a hospital for several days and she reported on examination at the clinic that she understood that the gall bladder had been distended but that the distention had subsided. There was no note of whether or not operation had been advised. The last acute attack had been in February, 1947. She had become quite nervous and rather depressed.

The results of physical examination were not of any moment other than that she was thin, having lost thirty pounds (13.6 kilograms). There was severe hypochromic anemia, the concentration of hemoglobin being 8.3 Gm. per 100 c.c. of blood and erythrocytes numbering 4,150,000 per cubic millimeter of blood. Roentgenologic examination revealed an obstruction at the outlet of the stomach, which was considered as probably due to an old, cicatrized duodenal ulcer. Gastric aspiration first disclosed a retention of 1,200 c.c. but this gradually decreased in the next few days. After the usual preoperative measures for pyloric obstruction, operation was undertaken on May 22. The stomach was dilated. A thickened, diseased gall bladder was imbedded in adhesions and contained a large stone. The gall bladder was adherent to the duodenum and the stone appeared as if it were beginning to burrow into the duodenum. Also there was evidence of an old duodenal ulcer so that the obstruction could have been due to both the old ulcer and the gall bladder with its stone imbedding itself in the wall of the duodenum. Cholecystectomy and gastroenterostomy were accomplished. The patient left the hospital on the twenty-third postoperative day. Some months later she reported that she was in excellent health.

Comment.—There is little to add other than that ten years of trouble had just about established a perforation into the duodenum. Possibly the duodenal ulcer did the patient a good turn by producing enough added narrowing of the pylorus so that aid was demanded before the cholecystoduodenal fistula was established.

The next case illustrates the difficulty of preoperative diagnosis when a stone blocking the duodenum develops inflammatory reaction and impending fistula.

CASE 3.—The patient, a woman aged 47 years, was admitted to the clinic Dec. 10, 1940. In 1936, she had suffered from a severe attack of right upper abdominal pain associated with nausea and vomiting. She had been taken to a hospital where she remained several days. On examination at the clinic she was not clear as to what had been decided but the attack had subsided and she had been dismissed with advice to eat a low fat diet. She had not tolerated fatty foods nor aromatic vegetables in the four years prior to examination at the clinic. In October, 1940, she had begun to have vomiting one hour after meals, associated with a tightness across the upper part of the abdomen. She had entered the local hospital where a diagnosis of duodenal obstruction had been made. Medical management for ulcer had been instituted and daily aspiration of the stomach had been carried out, 1,000 c.c. of gastric contents being obtained daily. As the condition had not improved, operation had been advised.

On admission to the clinic, she showed the effects of two months' obstruction but because of the foregoing medical management she was not critically ill. Physical examination disclosed tenderness and rigidity in the right side of the epigastrium. Roentgenologic studies confirmed the obstruction in the first portion of the duodenum with secondary dilatation of the stomach. Operation was undertaken on Dec. 17, 1940. A mass was found which obstructed the duodenum. This mass proved to be a subacutely inflamed gall bladder containing a large stone (4 by 3.5 cm.). It had become firmly attached to the duodenum and thereby almost completely blocked the latter. The activity of the process made it seem wiser to incise the gall bladder and remove the stone without endeavoring to dissect the gall bladder from the duodenum. There was also a definite possibility of a duodenal ulcer and this, together with the dilated stomach, prompted performance of posterior gastroenterostomy. The patient left the hospital on the twenty-second postoperative day. On re-examination in June, 1944, she was in good health and had only a mild dyspepsia but no pain nor vomiting. Roentgenologic study disclosed a nonfunctioning gall bladder. A well-functioning gastroenteric stoma was seen but it was doubtful if the pylorus was patent. In view of the patient's general good health, further surgical treatment for the gall bladder was not advised.

Comment.—This is rather a curious case. There was only the one severe attack, followed by moderate dyspepsia and then four years later symptoms of pyloric obstruction came on rather abruptly. This persisted until operation two months later, at which time the gall bladder had almost delivered its stone into the intestinal channel. From the standpoint of the pathologist the case is rather comparable to Case 2, but the actual duodenal obstruction due to cholecystitis with the large stone is more vividly demonstrated.

The story continues with the actual delivery of the stone into the duodenum and its progress down the intestinal tract. If this entrance to the duodenum can be accomplished before being interrupted, as in the two previous cases, the stone will usually work on down until impeded by some narrowing. This is often in the lower part of the ileum, where an intraluminal intestinal mass may be arrested—be it a mass of round worms, a ball of bran, or a gallstone. The next case illustrates this circumstance.

CASE 4.—The patient, a woman aged 55 years, was admitted to the clinic Aug. 21, 1939. At the age of 17 years she had had an attack of jaundice from which she had apparently recovered. For a number of years prior to admission she had had what she called spells of "gaseous indigestion" for two to three days every two to three months. These consisted of gas, fullness, and burning in the stomach one and one-half hours after meals, which were relieved by taking soda. She had not been awakened at night by this dyspepsia. She avoided eating pork and cabbage. In 1932 she had suffered from a severe attack of right upper abdominal pain associated with fever and residual tenderness for several days. There was no associated jaundice.

For the two years prior to admission to the clinic she had noted rather persistent distress and uneasiness in the upper part of the abdomen, but no actual pain from the severe attack in 1932 until Aug. 18, 1939, when she suffered from a sharp episode of intermittent, cramping, midabdominal pain, which seemed to extend from left to right. There were brief, sharp pains at intervals of ten to fifteen minutes. She began to vomit. These symptoms persisted with varying severity for the three days until admission to the clinic. The vomitus was green and bitter-tasting but not fecal in odor nor appearance. The bowels had not moved for the forty-eight hours prior to admission. A dose of cascara was vomited.

On physical examination, the abdomen was soft, but when she had a pain, peristaltic sounds were audible. A simple roentgenogram of the abdomen revealed a short segment

of distended small bowel in the upper part of the abdomen. A roentgenogram of the colon after administration of a barium enema was reported as normal. There was only a slight rise of temperature. The leucocyte count was 24,800 per cubic millimeter of blood and no anemia was present. Operation was advised for obstruction in the small intestine. This was performed on Aug. 22, 1939. There was a dilatation of the upper part of the jejunum to twice its normal size. About 4 feet (122 cm.) distal to the ligament of Treitz, the bowel was found obstructed by a gallstone measuring 2 by 4 inches (about 5 by 10 cm.). The stone was removed by incision, and the bowel was closed in the opposite direction. A cholecystoduodenal fistula was identified, with an opening of more than 1 inch (about 2.5 cm.) in diameter. The gall bladder was almost destroyed. The remnants of it were removed and the fistula was closed. The convalescence was relatively uneventful but slow, so that the patient did not leave the hospital until the thirty-fifth postoperative day. She returned a year later to have a postoperative hernia repaired but was otherwise in excellent health.

Ten of the 18 instances of obstruction, noted in the introduction, occurred in the lower 3 feet (about 91 cm.) of the ileum. In one-half of these 10 cases the patients suffered from recurrent attacks of abdominal distress which could be ascribed to cholecystic disease while in one-half there seemed to be only one attack of obstruction.

The intermittent type is illustrated by the following case.

CASE 5.—The patient, a woman aged 64 years, was admitted to the clinic Aug. 22, 1944. There had not been any prior abdominal operations. For the previous fourteen years she had had repeated attacks of epigastric pain, associated with nausea and vomiting. Through all these years, there had been intolerance to fatty, heavy foods. The day prior to admission she had felt miserable. That evening the same old pain came on, but this time it was of greater severity than others in the past. Nausea and vomiting began. At 1 A.M. on the day of admission, her physician administered morphine. An enema gave some temporary relief. At first the vomitus was green but it became brown and of a fecal odor.

Physical examination disclosed an obese woman. There was no apparent distention but pain and muscle-guarding were present in the right lower quadrant of the abdomen. A simple roentgenogram of the abdomen revealed distended loops of small bowel. Intranasal intubation, enemas, and heat gave some relief. The patient was enough relieved to permit sigmoidoscopic examination and roentgenographic examination after administration of a barium enema. The results of both were essentially negative except for diverticulosis of the sigmoid. The leucocyte count, which had been 11,000 per cubic millimeter of blood, declined to 5,700. At first, there was encouraging subjective as well as objective improvement, but evidence of more trouble was noted so that on Sept. 2, 1944, exploration for obstruction of the small bowel was undertaken. Free fluid was present. The colon was dilated. The terminal portion of the ileum was blocked by a large gallstone, measuring 4.5 by 2 by 3 cm. The ileum was incised and though the overlying wall was friable, it was possible to close the ileum longitudinally, and avoid resection. The patient was dismissed from the hospital on the twenty-sixth postoperative day.

CASE 6.—The patient, a woman aged 60 years, was admitted to the clinic Nov. 11, 1947. She had been under our care previously for diabetes. Appendectomy had been performed in 1908 and the left Fallopian tube and ovary had been removed in 1918. Except for the foregoing she had been quite well and active until one week prior to admission. She was awakened at 2 A.M. by a severe attack of right upper abdominal pain. The pain extended through into the back. Nausea and vomiting ensued. The bowels moved once but there was no movement thereafter. She was taken to a local hospital where enemas, fluids, and sedation were administered. Vomiting persisted and, while the pain was less severe, it likewise persisted.

On admission to the clinic on the seventh day of the illness, the patient was not critically ill. Temperature was 99° F. and pulse rate was 82. Leucocytes numbered 17,400 per cubic

millimeter of blood. Physical examination did not disclose abdominal distention but the right midabdomen was quite tender. A simple roentgenogram of the abdomen did not show distended loops of bowel. In view of the vomiting and depletion for the week, intestinal intubation was begun and the other usual measures for probable intestinal obstruction were employed. On the third day after the patient's admission to the clinic the roentgenogram after administration of a barium enema was normal but loops of small bowel were seen to be distended. On November 17, operation was undertaken, with the preoperative diagnosis of obstruction of the small bowel. An obstruction in the lower part of the ileum was found, which proved to be a gallstone the size of a hen's egg (Fig. 1). The ileum was incised and the stone was removed. In the upper right quadrant of the abdomen, there were multiple adhesions around the gall bladder, which was plastered to the duodenum. The patient's convalescence was prolonged by a flare-up of the diabetes and by pleural effusion, so that she was not dismissed until the forty-sixth postoperative day.

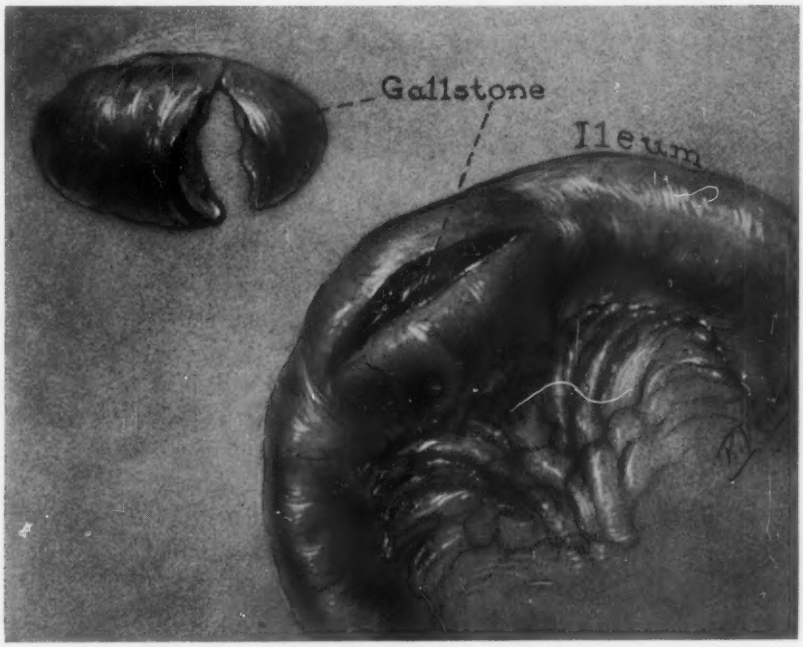

Fig. 1.—Gallstone obstructing the ileum.

The obvious point to emphasize in both these cases is the management of the obstruction. In Case 5, there can be seen the clue of gallstone disease but certainly there is no such clue in Case 6. It is the recognition and preoperative care of these patients or of any patient who has obstruction that does so much to protect them. This regimen, which now includes antibiotics and sulfonamide drugs, has made it possible to save the great majority of all patients suffering from obstruction.

SUMMARY

Eighteen cases of intestinal obstruction due to gallstone, encountered at the Mayo Clinic, have been summarized. Such obstruction is a complication of cholelithiasis which, while rare, occurs mostly in women and is also to be expected usually in patients over the age of 50 years. Selected case reports depict the journey of a stone from the gall bladder to its impaction in the bowel.

While a presumptive preoperative diagnosis is possible in about one-third of the cases, undue academic enthusiasm to make a positive diagnosis must usually give way to the practical measures to care for the obstruction. It is the awareness of both the physician and the surgeon of the probable obstruction which will safeguard patients suffering from intestinal obstruction.

REFERENCES

1. Wakefield, E. G., Vickers, P. M., and Walters, Waltman: Cholecystoenteric Fistulas, SURGERY 5: 674-677, 1939.
2. Wakefield, E. G., Vickers, P. M., and Walters, Waltman: Intestinal Obstruction Caused by Gallstones, SURGERY 5: 670-673, 1939.
3. Harris, W. L., McNamara, C. E., and Dardinski, V. J.: Gallstone Obstruction of the Intestine; a Brief Review of the Literature With Report of Four Cases, M. Ann. District of Columbia 16: 422-425, 1947.
4. Downing, W. L.: Gallstone Ileus; Report of Five Cases, J. Iowa M. Soc. 38: 95-100, 1948.

STUDIES ON BURNS

IV. Further Observations on a Vasoconstrictor Substance in Lymph From a Burned Area

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THE presence or absence of a toxin in a burned area has been a controversial subject over a period of years. Several years ago evidence was presented from this laboratory suggesting that lymph from a burned area contains a vasoconstrictor substance which is not present in lymph from undamaged tissue.[1] The method used in testing samples in that experiment was perfusion of an isolated rabbit's ear with pre-heparinized blood.[2] It was realized that this method is not entirely satisfactory since the test preparation is sensitive to vasoconstrictor materials which result from the process of coagulation. The presence of such materials was avoided as completely as possible by pre-heparinization of the animals from which lymph samples were obtained. The present report comprises further studies of lymph from a burned area by four methods to detect the possible presence of a vasoconstrictor material. It refutes the tentative conclusion previously reported.

METHODS

Lymph samples were collected from lymphatics leading from burned areas in dogs. The animals had been given heparin intravenously before being burned in an effort to prevent the formation of vasoconstrictor materials resulting from coagulation. A standard hot water burn of the paw (100° C. for 1 minute) was accomplished by the method of Glenn, Peterson, and Drinker.[2] Control lymph samples and hourly lymph samples after the standard burn were collected from each animal and were tested by each of four methods. The method used previously and described by Landis and his associates[3] was repeated employing ½ c.c. samples of lymph. Second, the Laewen-Trendelenburg method of perfusion of the hind limbs of a frog was used. The lymph samples in 1 c.c. amounts were injected into the perfusion fluid just before it entered the cannula in the abdominal aorta of the preparation. The third method was the Adrenalin reactivity of the arterioles of the rat meso-appendix as described by Chambers.[4] A separate animal was used for testing each lymph sample, and ¼ c.c. amounts of lymph were injected. The fourth method was the observation of the effect on the mean arterial blood pressure in the intact rat under light nembutal anesthesia of injected lymph samples from burned areas. The mean arterial pressure was obtained by placing a cannula in a carotid artery and connecting it to a mercury manometer constructed from 2 mm. tubing. Pressure readings were taken at one-minute intervals. Lymph samples were tested by injection of ¼ to ½ c.c. into a jugular vein.

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In each application of each of the four methods the accuracy of the test preparation was determined by the use, first, of normal saline to determine the effects of the volume of material being tested; second, of adrenalin to determine the sensitivity to a vasoconstrictor material.

RESULTS

The findings in eight normal lymph samples and eight lymph samples from a burned area tested by injection into an isolated rabbit's ear perfused with pre-heparinized blood are recorded in Table I. There was no vasoconstrictor response to the normal samples, but the lymph collected after burning caused slight vasoconstriction in this preparation. This response was less marked than that previously reported with this method.[1]

TABLE I. EFFECT OF 0.5 C.C. INJECTIONS OF LYMPH ON VASCULAR TONE IN THE RABBIT'S EAR PERFUSED WITH "PRE-HEPARINIZED" RABBIT'S BLOOD

1	2	3	4	5	6
SAMPLE	NUMBER OF INJECTIONS	AVERAGE RATE OF FLOW (DROPS PER MINUTE)	MAXIMUM REDUCTION OF FLOW AFTER INJECTION	AVERAGE TIME FOR FLOW TO RETURN TO NORMAL (IN MINUTES)	AREA OF DECREASED FLOW CURVE (IN SQ. IN.)
Control lymph	8	16	0	0	0.00
Burn lymph	8	16	9%	4	0.13

The results from the perfusion of the hind legs of a frog preparation are shown in Table II. There was a slight decrease in the flow curve area with both the control lymph and the lymph from a burned area.

The average response for normal lymph samples and lymph samples from a burned area when tested by the adrenalin reactivity of the arterioles of the rat meso-appendix technique is given in Fig. 1. The normal lymph and the

TABLE II. EFFECTS OF 1.0 C.C. INJECTIONS OF LYMPH ON VASCULAR TONE IN THE FROG'S HIND LEGS PERFUSED WITH NORMAL SALINE SOLUTION

1	2	3	4	5	6
SAMPLE	NUMBER OF INJECTIONS	AVERAGE RATE OF FLOW (DROPS PER MINUTE)	MAXIMUM REDUCTION OF FLOW AFTER INJECTION	AVERAGE TIME FOR FLOW TO RETURN TO NORMAL (IN MINUTES)	AREA OF DECREASED FLOW CURVE (IN SQ. IN.)
Control lymph	14	20	9%	2.7	−0.05 (+0.03 to −0.24)
Second hour burn lymph	13	19	12%	4.0	−0.06 (+0.01 to −0.17)
Third hour burn lymph	13	19	14%	3.8	−0.05 (+0.01 to −0.19)
Fourth hour burn lymph	13	18	12%	4.0	−0.06 (+0.00 to −0.12)
Fifth hour burn lymph	12	19	12%	4.7	−0.06 (+0.00 to −0.17)

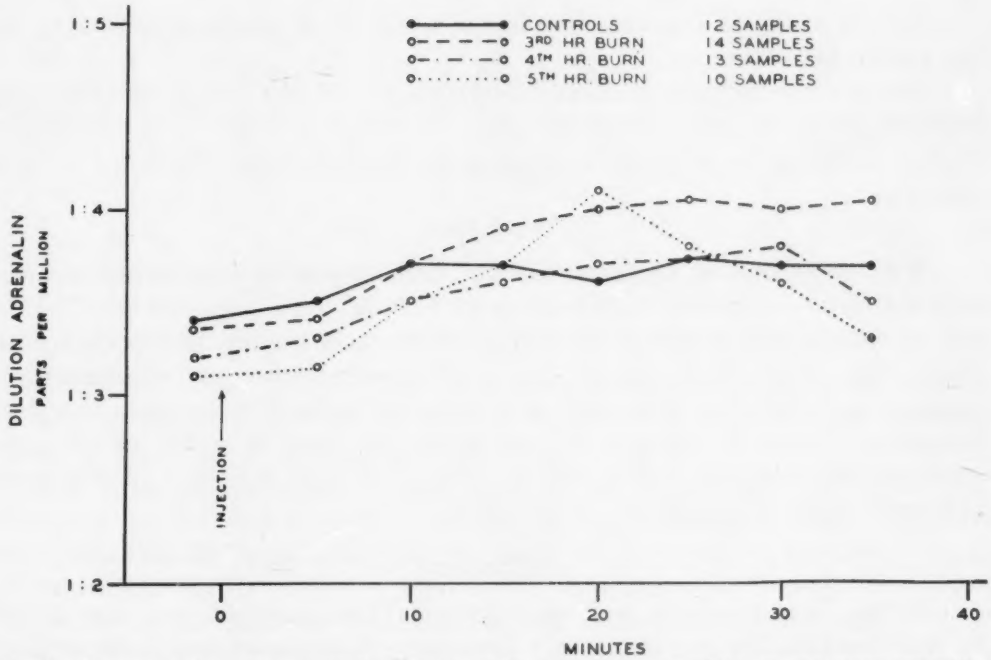

Fig. 1.—Average adrenalin reactivity curves (0.25 c.c. lymph samples) in rat meso-appendix.

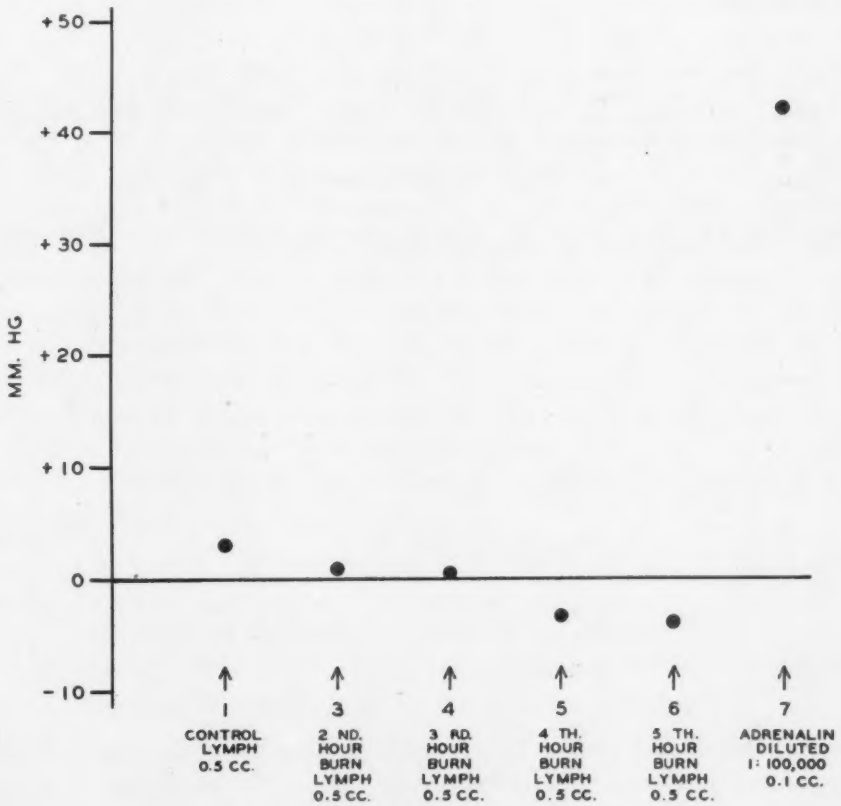

Fig. 2.—Average blood pressure changes in intact rat.

lymph from a burned area samples did not result in an increased sensitivity of the vessels to adrenalin.

The average changes in mean blood pressure in the intact rat following injection of the various lymph samples are shown in Fig. 2. A significant change in the mean arterial blood pressure did not result from any of the samples.

COMMENT

With repetition of the perfused ear method, less striking evidence of a vasoconstrictor substance in lymph from burned areas was observed. This may be due to further experience with the method, resulting in less chance of error. The three other methods showed no results suggesting vasoconstrictor material in lymph from a burned area. On the basis of these experiments it becomes necessary to abandon the conception in favor of which preliminary evidence was presented earlier, namely, that in the lymph from a burned area vasoconstrictor substances can be detected.

CONCLUSIONS

Normal lymph samples and lymph samples from a burned area were tested by four methods for vasoconstrictor materials. These were not demonstrated other than those resulting from the process of coagulation which affects isolated perfused tissues.

REFERENCES

1. Alrich, E. M.: Studies on Burns II, SURGERY **15**: 908-912, 1944.
2. Glenn, W. W. L., Peterson, D. K., and Drinker, C. K.: Flow of Lymph From Burned Tissue, With Particular Reference to the Effects of Fibrin Formation Upon Lymph Drainage and Composition, SURGERY **12**: 685-693, 1942.
3. Landis, E. M., Wood, J. E., and Querrant, J. L.: Effect of Heparin on the Vasoconstrictor Action of Shed Blood Tested by Perfusion of the Rabbit's Ear, Am. J. Physiol. **139**: 26-38, 1943.
4. Chambers, R., and Zweifoch, B. W.: Topography and Function of the Mesenteric Capillary Circulation, Am. J. Anat. **75**: 173-198, 1944.

Case Reports

RIGHT PARADUODENAL HERNIA

With Report of a Case

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AMONG surgical diseases of the abdomen, paraduodenal hernia is relatively uncommon. Moynihan[1] in his book *On Retroperitoneal Hernia* described nine fossae in the paraduodenal region. The two chief varieties of Hernia arising in the neighborhood of these fossae are left duodenal hernia and right duodenal hernia. These hernias have their origin in the paraduodenal fossa of Landzert and the mesentericoparietal fossa of Waldeyer, respectively. Left paraduodenal hernia occurs approximately three times as frequently as right paraduodenal hernia. We have been able to find reports of 50 cases of right paraduodenal hernia, with 31 operations and 18 recoveries.

The mesentericoparietal fossa was first described by Waldeyer in 1874. He described the fossa as being formed by the superior mesenteric artery raising up peritoneal folds as it arches downward with slightly concave curve to the right. He had seen this fossa several times in post-mortem examinations of embryos but had never observed it in an adult.

Following this original observation, the mesentericoparietal fossa was seen and described in adults. The usual position of the fossa is in the first part of the mesojejunum immediately behind the superior mesenteric artery and immediately below the duodenum. The fossa varies considerably in size. Its orifice looks to the left, its blind extremity to the right and downward. In front it is bounded by the superior mesenteric artery and behind by the lumbar vertabrae. The peritoneum of the leaf of the mesentery lines the fossa, the blind end being continued directly into the posterior parietal peritoneum. A forcible enlargement of the fossa would thus result in a tearing up of this layer of peritoneum lining the posterior abdominal wall.

According to Moynihan,[1] the following conditions are found in a right paraduodenal hernia:

1. The sac in the early stages is in the right half of the abdominal cavity.
2. The orifice is situated to the left of the sac.
3. The anterior margin of the sac contains either the superior mesenteric artery or a continuation of it, the ileocolic artery.

The first authenticated case of this type of hernia was recorded by Klob[2] in 1861 in a man, aged 36 years. He described the hernia as follows: "On

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opening the abdomen, one could see nothing of the small intestine. After turning up the great omentum and transverse colon, there appeared occupying the right half of the abdominal cavity reaching to the middle line a mass 8 inches long, 6 inches wide and 5 inches deep. The upper portion was covered by the transverse mesocolon; to the right lay the ascending colon; below the sac lay the pelvis. The orifice of the sac lay to the left and behind, was about 2 inches in diameter and was situated on the third lumbar vertebra. In the thin, anterior margin of the orifice lay the ileocolic artery."

Moynihan[1] and Garber[3] both considered the chief diagnostic signs to be:

1. Repeated attacks of abdominal colic
2. Abdominal tenderness with distention relieved by the passing of flatus
3. Visible peristalsis and a palpable, tympanic, elastic mass in the abdomen

Most right paraduodenal hernias have been discovered at autopsy or found at operation when an exploratory laparotomy was done for suspected high small bowel obstruction. The first preoperative diagnosis was made by Taylor[4] in 1930 by x-ray examination.

In 1926 Case and Upson[5] listed as differential points in the x-ray diagnosis:

1. Abnormal location of jejunum on the right side of the abdomen
2. Downward continuation of the jejunum from the second portion of the duodenum
3. Absence of the transverse third and ascending fourth portions of the duodenum traveling to the left across the spine
4. Dilatation of the duodenum as a result of constriction or angulation of the proximal part of the jejunum by the neck of the peritoneal sac, thus causing the symptoms of high intestinal obstruction, with relief by vomiting

Exner[6] in 1933 pointed out that the following x-ray findings may aid in the preoperative diagnosis:

1. The intestinal coils have a clumped appearance as if they were in a bag.
2. It is impossible to displace the intestinal coils from this circumscribed mass by manipulation or change of position.
3. The axis of the ovoid mass of bowel loop is usually somewhat to the right of the midline of the body.
4. In the erect position the corpus of the stomach seems to sag down to the left of the sac, while the antrum and pylorus are held up in position.
5. There tends to be an absence of small bowel loops in the pelvis.
6. The herniated bowel shows some loss of motility, so that there is more or less delay in the passage of barium through the sac.
7. It is possible at times to visualize the point of exit from the sac by an abrupt change in the caliber of the bowel as it emerges.

Scheele[7] stated that roentgenograms taken following a barium meal show retention in the stomach and duodenum, with a bow-shaped closing off of the upper intestinal shadow.

In spite of the excellent articles by Moynihan and Dobson and Garber on the physical signs and by Scheele, Case and Upson, and Exner on the x-ray diagnosis of right paraduodenal hernia, Cogswell and Thomas[8] in 1941 stated that the preoperative diagnosis had been made only twice. Both of these diagnoses were made by x-ray examination, one by Taylor[4] and one by Exner.[6] A third case of paraduodenal hernia was diagnosed preoperatively by Case and Upson[5] which was probably a right paraduodenal hernia but this was not definitely stated.

Because right paraduodenal hernia in itself is an uncommon surgical condition and since as far as we are able to determine, we have observed the first case which has occurred following a subtotal gastric resection, we believe the following case to be of interest.

Fig. 1.—Roentgenogram of the abdomen in upright position. Note the haziness in the right upper abdomen which extends over into the left upper abdomen. Air is seen within the lumen of the large bowel but there is a striking absence of air in the small bowel.

CASE REPORT

J. K., a white man, aged 64 years, was admitted to the Salt Lake General Hospital on Aug. 18, 1947, complaining of abdominal pain, nausea, and vomiting.

Illness at Time of Admission.—Four months prior to admission, the patient had had a subtotal gastric resection in another hospital for what was thought to be a gastric ulcer, but pathologic sections revealed a small cell sarcoma of the stomach. An anterior Polya, isoperistaltic anastomosis had been made. Postoperatively the patient had done well, returning to his former occupation, and gaining eight pounds in the interim. Nine hours

before admission he noted a dull aching pain in the epigastrium. Six hours before admission this pain suddenly became very severe and was accompanied by nausea and vomiting (ten to twelve times). There was no hematemesis. He had had a normal bowel movement just prior to the onset of the pain. There was no history of melena.

Physical Examination.—Temperature was 99° F., pulse 90, respirations 32, blood pressure 160/94. The patient was a well-developed, fairly well-nourished, somewhat pale white man who appeared acutely ill. The skin was moist and clammy. Lungs were normal on percussion and auscultation. The heart was not enlarged, the rhythm was regular, and there were no murmurs. The abdominal wall was rigid. There was generalized abdominal tenderness to palpation and rebound tenderness. No masses could be palpated through the rigid abdominal wall. Liver dullness was not obliterated on percussion. An occasional bowel sound was heard but typical borborygmus or high pitched bowel sounds were not heard.

Laboratory Data.—Urinalysis was negative, hemoglobin 14.5 Gm., white blood cell count, 16,000.

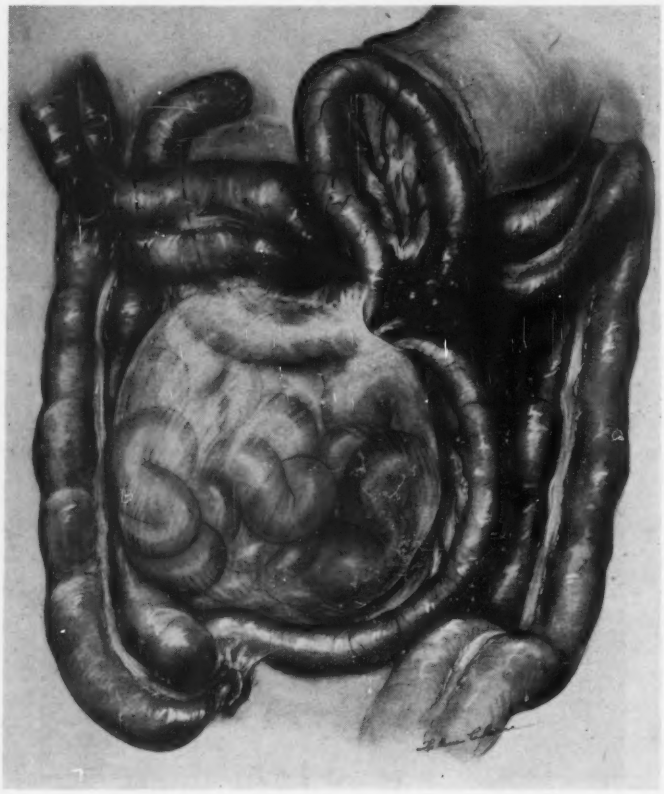

Fig. 2.—Diagram illustrating the hernia as seen at operation. The sac fills the right side of the abdomen and extends over the midline toward the left. The orifice of the sac is seen on the upper left portion of the sac.

X-Ray Examinations.—An upright film (Fig. 1) of the abdomen and right and left lateral films showed a haziness over the upper portion of the abdomen. There was no evidence of free air beneath the diaphragm.

Course.—About one hour after the patient was admitted to the hospital, an exploratory laparotomy was done. On opening the peritoneum, free fluid was not encountered. None of the small intestine was visible except the afferent loop of the gastrojejunal anastomosis and the terminal ileum. After turning up the greater omentum and transverse colon there appeared a large mass (Fig. 2) occupying the right half of the abdominal cavity and extending across the midline into the upper half of the left side of the abdominal cavity. The

orifice of the mass lay to the left and behind. The transverse colon was anterior to the mass and the ascending colon was just to its right. When the gastrojejunostomy was examined, the afferent loop was found to be somewhat distended and edematous while the efferent loop was found to be pulled down toward the base of the mass on the left side and its lumen completely occluded as it entered the base of the mass. The portion of terminal ileum which was exposed was followed up toward the jejunum and by gentle traction on it, reduction of the hernia was accomplished. After reduction of the hernia, the orifice of the sac was found to be about one and one-half inches in diameter to the left and behind the major portion of the sac, and in its anterior margin the superior mesenteric artery could be palpated. The orifice was closed with interrupted silk sutures. The gastrojejunostomy was inspected and found to be functioning and the abdomen was closed. Postoperatively, the patient did well and was discharged on the sixth postoperative day in good condition. When seen one month later he had no complaints.

DISCUSSION

The diagnosis in this case was not suspected preoperatively. The most likely diagnosis seemed to be a perforation in the region of the gastrojejunal anastomosis. In retrospect the presence of the haziness in the upper abdomen on x-ray examination might have aided us in suspecting the diagnosis. Also, the major portion of the jejunum was located on the right side of the abdomen. Since this case occurred following a subtotal gastric resection, there was no absence of the transverse third and ascending fourth portions of the duodenum traveling to the left across the spine as mentioned by Case and Upson[5] because the efferent loop of the gastrojejunostomy was the portion of jejunum herniated into the mesentericoparietal fossa.

Two varieties of right duodenal hernia are recognized by Moynihan.[1]

1. Those in which the fossa exists in association with an adherent jejunum. The length of the jejunum fused to the posterior abdominal wall may vary from one-half inch up to four inches.

2. Those in which the fossa exists in the uppermost portion of the mesojejunum close to the duodenum. The jejunum has, in these cases, a free mesentery from its origin.

For the first variety, the term "hernia mesentericoparietalis, parajejunalis" would be applicable, and for the latter "hernia mesentericoparietalis, paraduodenalis."

This hernia falls into the second, or hernia mesentericoparietalis, paraduodenalis group and it also fulfills all of the requirements of Moynihan for a right paraduodenal hernia.

It might be speculated that the gastrojejunostomy done at the time of the subtotal gastric resection may have increased the exposure of the existing duodenal fossa to the loops of small bowel. We wonder if this would contribute toward the possibility of formation of such a hernia in those patients in whom there was a right paraduodenal fossa.

SUMMARY

1. Paraduodenal hernia is a condition in which most of the small bowel is incarcerated within a peritoneal sac which is itself retroperitoneal, making its entrance in the area of the duodenojejunal junction.

2. Right paraduodenal hernia is much less common than left paraduodenal hernia.

3. Anatomic relationships, symptoms, physical findings, and x-ray findings of right paraduodenal hernia are discussed.

4. We have found reports of 50 cases of right paraduodenal hernia with 31 of the patients having been operated upon and 18 having recovered. The additional patient reported was operated upon and recovered and, to our knowledge, is the first case reported in which the hernia was found following a subtotal gastric resection.

REFERENCES

1. Moynihan, B. G. A., and Dobson, J. F.: On Retroperitoneal Hernia, ed. 2, New York, 1906, William Wood & Company.
2. Klob, J.: Hernia Retroperitonalis. Wochenblatt der Zeitschrift der K. K. Gesellschaft der Aerzte in Wein., 1861-1870 (June 12, 1861).
3. Garber, N.: Ein Fall von Hernia Duodenojejunalis Treitzii, Arch. f. klin. Chir. **153**: 316-325, 1928.
4. Taylor, J.: X-ray Diagnosis of Right Paraduodenal Hernia, Brit. J. Surg. **17**: 639, 1930.
5. Case, U. T., and Upson, W. O.: Roentgenologic Aspect of Various Types of Hernia, J. A. M. A. **87**: 891-898, 1926.
6. Exner, F. B.: Roentgen Diagnosis of Right Paraduodenal Hernia; Report of Case With Survey of Literature, Am. Jour. Roentgenol. **29**: 585-599, 1933.
7. Scheele, K.: Diagnosis of Duodenojejunal Hernia, Zentralbl. f. Chir. **48**: 188, 1921.
8. Cogswell, H. D., and Thomas, C. A.: Right Paraduodenal Hernia, Ann. Surg. **114**: 1035-1041, 1941.

CYSTS OF PARATHYROID ORIGIN

Report of Two Cases and Study of Incidence and Pathogenesis of Cysts in Parathyroid Glands

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CYSTS in the walls of which parathyroid tissue may be found are occasionally seen in the usual situations of the parathyroid glands. Several reports of such lesions have appeared in European journals, but we could find in the American literature only one report of a case in which the lesion was recognized clinically.[1] In contrast to the few reported cases in which the condition was encountered clinically, virtually all systematic studies of parathyroid glands have revealed many parathyroid cysts. Two such cases were encountered on the surgical service of one of us (B. M. B.) during a period of a few months. The finding of the second cyst along with the scarcity of reports of such cases in the literature occasioned the present review.

The first case of the surgical removal of a parathyroid cyst to be reported was that of Goris[2] in 1906. The tumor consisted of three closely applied cysts that contained degenerated parathyroid tissue. Anzilotti,[3] in 1909, removed a similar cyst, the size of an egg, from the locality of the right inferior parathyroid gland. The cyst was partially lined by ciliated epithelium, and several masses of parathyroid tissue were found in the wall of the cyst. DeQuervain,[4] in 1925, encountered a pale, yellow cyst, in the wall of which parathyroid tissue was found, in the anterior part of the superior mediastinum during the removal of a substernal goiter. Nylander,[5] in 1929, removed a cyst the size of a goose egg from the anterior cervical region of a 16-year-old boy. The cyst was lined with cuboidal and columnar epithelium and a nodule of parathyroid tissue was present in its wall. Welti,[6] in 1946, reported 2 such cases, 1 of which had been encountered fourteen years before. Both cysts were situated behind the inferior pole of the thyroid gland. There was no anatomic connection with the thyroid gland, and parathyroid tissue was present in the walls of both cysts. In a personal communication, Welti[7] informed us that he had encountered recently a third case which he has not yet reported. McKnight[1] reported, in 1946, the only case in the American literature in which the lesion was recognized clinically. The cyst was identical to those reported by Welti. It was the size of a golf ball, it displaced the lower pole of the left lobe of the thyroid anteriorly, and parathyroid tissue was found in the wall of the cyst.

REPORT OF CASES

Case 1.—A 32-year-old woman had had a sensation of tenseness in the lower part of the neck for some years. Eight years previously she had been told elsewhere that there was a nodule in the left lobe of the thyroid gland. On examination, the nodule in the region of the lower pole of the left lobe of the thyroid measured approximately 2 cm. in diameter. The basal metabolic rate was +6 and there were no evidences of hyperparathyroidism. At operation, both lobes of the thyroid gland were normal in size and consistency and the pal-

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pable nodule proved to be a cyst situated behind and slightly distal to the inferior pole of the left lobe of the thyroid. The cyst was situated anterior to the inferior thyroid artery and the recurrent laryngeal nerve, and had displaced the left lobe of the thyroid forward. It was not connected to the capsule of the thyroid or other structures and was easily removed by blunt dissection.

Pathologic Examination.—The specimen consisted of a unilocular thin-walled cyst 4 cm. in diameter. One part of the cyst wall measuring 5 by 4 mm. was yellowish brown in color and was 2 mm. thicker than the remainder of the cyst wall. The wall of the cyst was composed of fibrous connective tissue lined incompletely with cuboidal cells, which in some regions appeared quite flattened. The nuclei of the cells were round to oval in shape and stained rather deeply. In one region the cells were larger and stained so lightly that they resembled the wasserhelle cells seen in the parathyroid gland (Fig. 1, *a*). Examination of the small thickened part in the cyst wall revealed islands of compressed parathyroid tissue irregularly dispersed in the fibrous connective tissue (Fig. 1, *b*). The parathyroid tissue consisted mainly of principal or chief cells.

Fig. 1 (Case 1).—*a*, The cells lining the cyst wall resemble wasserhelle cells (hematoxylin and eosin ×365). *b*, Same region as that shown in *a*. The parathyroid tissue consists mainly of principal or chief cells (hematoxylin and eosin ×125).

CASE 2.—The patient was a man 30 years of age. Cervical exploration had been advised because of hyperparathyroidism. Both lobes of the thyroid were found to be normal in size and consistency. The left superior parathyroid gland was replaced by an adenoma which weighed 200 mg. On the right side, in the usual position of the right superior parathyroid gland, a cyst 1 cm. in diameter was found. The cyst was not attached to any other structure in the neck. The cyst and the parathyroid adenoma were removed. Postoperatively the levels of serum calcium and phosphorus returned promptly to normal.

Pathologic Examination.—The cyst was unilocular and measured 1 cm. in diameter. The wall of the cyst consisted of fibrous connective tissue lined incompletely with low cuboidal cells. The nuclei of the lining cells were round to oval and stained rather deeply. The cytoplasm of the cells appeared pale and finely granular. In several places islands of compressed parathyroid tissue were found in or attached to the cyst wall (Fig. 2, *a*). In one region parathyroid tissue seemed to be forming the lining of the cyst (Fig. 2, *b*). The parathyroid tissue consisted mainly of principal or chief cells. The adenoma was a typical benign parathyroid tumor.

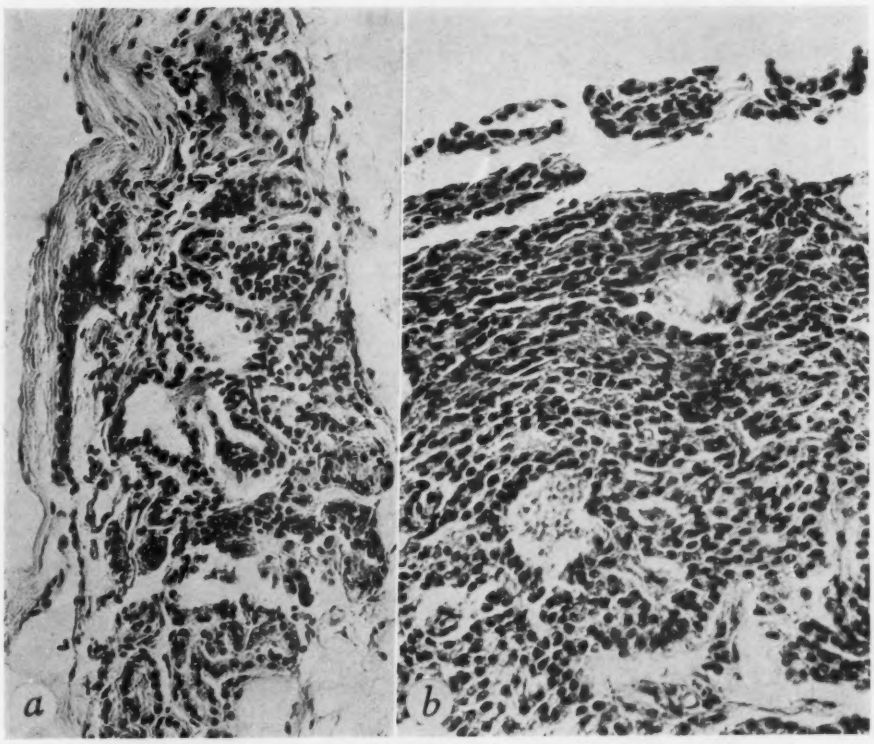

Fig. 2 (Case 2).—*a*, Small island of parathyroid tissue in the cyst wall (hematoxylin and eosin ×200). *b*, Parathyroid tissue forming the lining of the cyst wall and consisting mainly of principal or chief cells (hematoxylin and eosin ×275).

In 4 other cases, cysts in the location of a parathyroid gland large enough to be palpable have been removed surgically at the Mayo Clinic. The gross appearance of the cysts was similar to that in the previous cases but parathyroid tissue could not be found in their walls. Three of the cysts were located on the left side and 1 on the right. All were situated somewhat behind and distal to the inferior pole of the thyroid gland. Two cysts extended into the anterior part of the superior mediastinum, both displaced the trachea and one was adherent to the esophagus. None were attached to the thyroid gland and all lay anterior to the inferior thyroid artery and recurrent laryngeal nerve. The largest cyst measured 8 by 5 by 4 cm. and the smallest cyst measured 3.5 by 3 by 3 cm. The cyst walls were composed of fibrous connective tissue and were lined solely by hyalinized connective tissue without epithelium. Anatomically these 4 cysts were situated in a location one would expect cysts arising from

parathyroid tissue to occupy. The parathyroid cysts reported on by Anzilotti, Welti, and McKnight and the one in our Case 1 were situated precisely in this same location. We have considered the 4 cysts to be of the same nature as those described more fully previously. However, their parathyroid origin is not certain since parathyroid tissue was not present in the walls and since cysts of other origin may be found in this location.

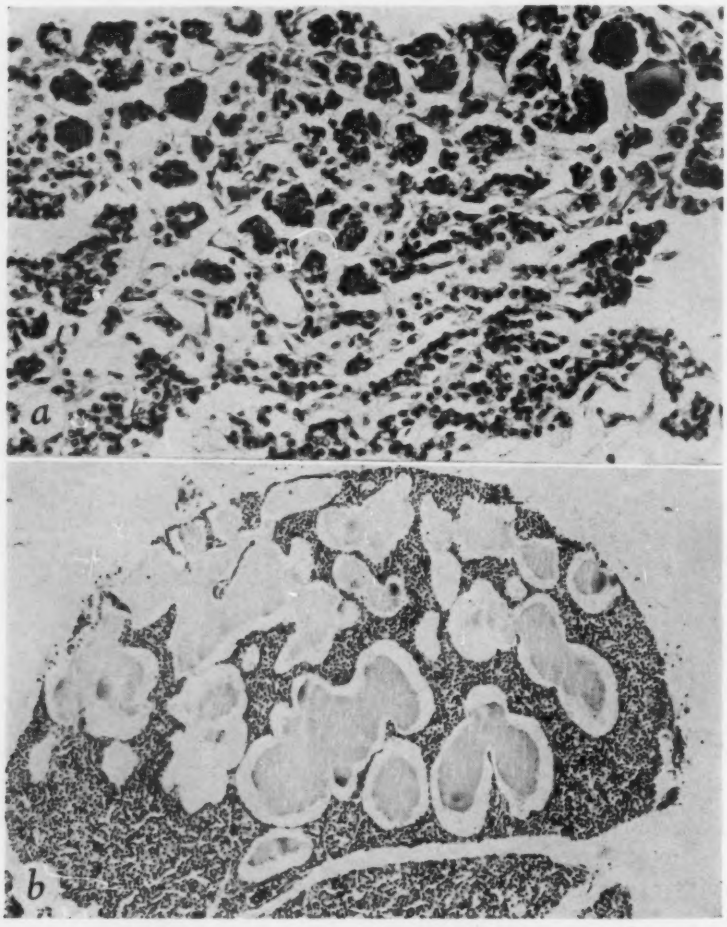

Fig. 3.—Parathyroid gland. Stained with hematoxylin and eosin. *a*, Small colloid-filled vesicles found in 84 per cent of the parathyroid glands at routine necropsy (×185). *b*, Multiple small colloid-filled cysts with diameters varying between 100 and 400 microns (×47).

INCIDENCE AND PATHOGENESIS OF PARATHYROID CYSTS

In view of the frequency with which cysts have been found whenever parathyroid glands have been studied at necropsy and in an effort to understand more fully the development of the large cysts occasionally found at operation, parathyroid glands obtained at 100 consecutive necropsies were studied. The glands were fixed in a 10 per cent solution of formalin and embedded in paraffin. Sections were cut approximately 8 microns thick and were stained with hematoxylin and eosin. Some of the sections containing cysts were stained for

mucus by the Dresbach modification of Mayer's mucicarmine method. Serial sections were not employed nor could 4 parathyroid glands be found and sectioned in every case. In 96 cases the parathyroid glands were thought to be normal; in 2, the glands had undergone hypertrophy and hyperplasia secondary to chronic renal disease; in 1, the glands were infiltrated with leucemic cells, and in 1 an adenoma, which had produced severe hyperparathyroidism, was present in 1 gland while the remaining glands could not be identified.

No striking histologic differences were encountered in this series from those described in standard textbooks. The vast majority of the epithelial cells were arranged in solid masses and cords. Although there were no ducts, small vesicles were scattered here and there in the parenchyma. Occasionally, clumps of epithelial cells surrounded a tiny central lumen. In certain cases alveoli lined with a single row of columnar cells were seen. More frequently, vesicles lined with a single row of nonciliated cuboidal cells were present. The cytoplasm of the lining cells was rather scanty and the cells possessed deeply staining, prominent nuclei. The majority of vesicles were from 10 to 40 microns in diameter, although some were much larger (Fig. 3, *a*). The lumina of the vesicles usually contained homogenous material which resembled colloid, but it is known that this so-called colloid differs from that seen in the thyroid in that it contains no iodine.[8] Any albuminous material in a closed cavity may resemble colloid.[9] The number of vesicles increases with age so that in adults vesicles can be found in practically all parathyroid glands.[10]

The frequency with which cysts are encountered in the parathyroid glands has been commented on frequently. Thompson and Harris[11] reported that microscopic cysts were present in 5 per cent of routine necropsies, Petersen[12] in 6 per cent, and von Verebély[13, 14] in 12 per cent. Castleman and Mallory[15] found cysts of varying sizes in approximately 50 per cent of 150 patients beyond puberty who came to necropsy, and in 2 of their cases a parathyroid gland had been almost wholly replaced by a single cyst. Gilmour[10] found 12 gross cysts

TABLE I. INCIDENCE OF CYSTS IN THE PARATHYROID GLANDS FROM ONE HUNDRED ROUTINE NECROPSY CASES

DIAMETER OF DILATED VESICLES OR CYSTS (MICRONS)	CASES	TOTAL
Microcysts		
100-199	12	22 (22%)
200-299	6	
300-399	4	
Macrocysts		
400-499	6	20 (20%)
500-599	1	
600-699	1	
700-799	4	
900-999	2	
1,200*	2*	
1,800*	1*	
2,850*	1*	
3,000*	1*	
4,600*	1*	
Total		42 (42%)

*Cysts with a diameter greater than 1 mm. in 6 cases.

in 428 necropsies and reported that in his series microscopic cysts were present in 20 per cent of the 10 infants less than 24 hours old, in 41 per cent of the 17 children between the ages of 1 and 5 years, and in 74 per cent of the 23 adults over 20 years of age. In the series of 250 necropsies of Thompson and Harris, only 2 parathyroid cysts were of appreciable size. The larger measured 2 by 2 by 0.5 cm. and the smaller measured 0.7 by 0.4 by 0.3 cm. These disparate incidences are probably explainable on the basis of individual conception of vesicle or cyst.

In the present series, well-developed vesicles that contained colloid were found in 1 or more parathyroid glands in 84 of the 100 cases (Fig. 3, *a*). It is

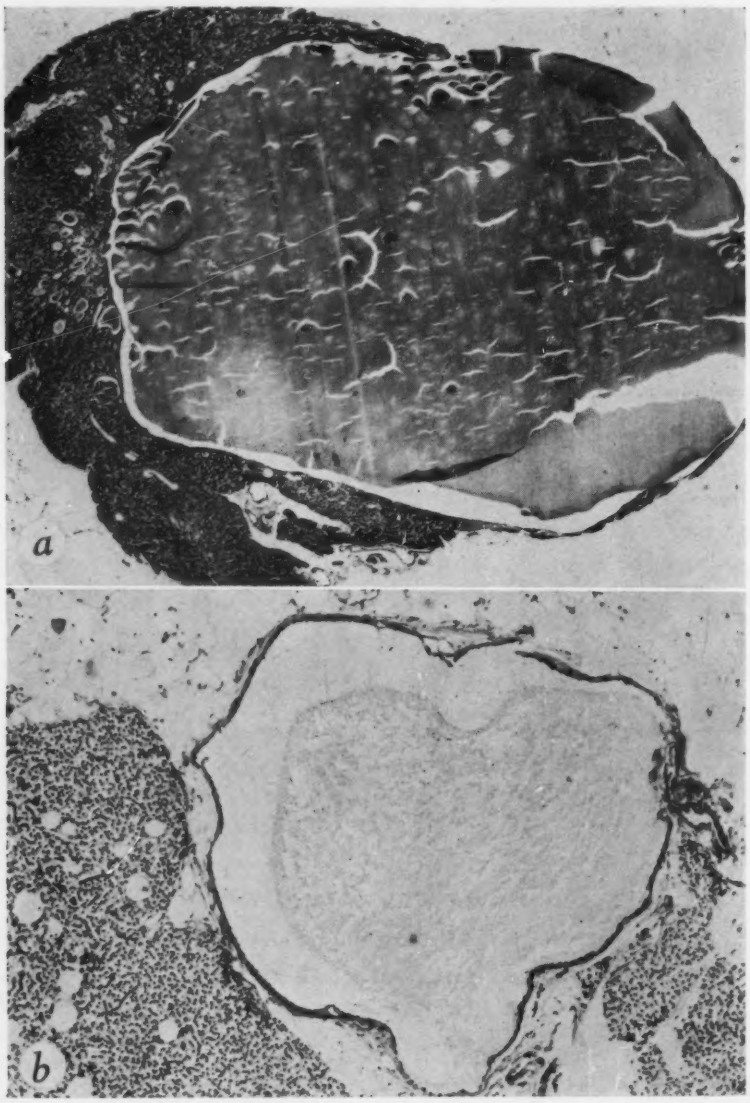

Fig. 4.—*a*, Parathyroid gland. Stained with hematoxylin and eosin. Multiple colloid-filled cysts, the largest of which is 4,600 microns in diameter (×20). *b*, A colloid-filled cyst 1,000 microns in diameter. Note the flattened cuboidal lining cells (×65).

probable that the employment of serial sections and the study of all parathyroid glands from each case would have revealed the presence of vesicles in more cases. Cysts larger than 100 microns were encountered in 42 cases (Table I). In 22 of these cases the diameters of the cysts varied between 100 and 400 microns (Fig. 3, *b*) and in 20 the diameters varied between 400 and 4,600 microns. In 6 cases of the latter group the cysts were larger than 1 mm. (1,000 microns) in diameter (Fig. 4, *a*).

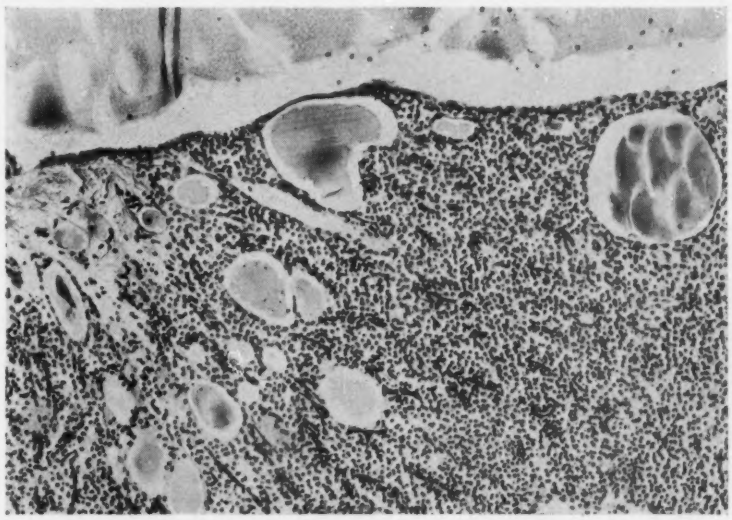

Fig. 5.—Parathyroid gland containing multiple colloid-filled cysts. Numerous transitional stages from the smallest colloid-filled vesicle to the largest cyst can be seen (hematoxylin and eosin ×125).

Of the 20 cases in which there were definite cysts greater than 400 microns in diameter, 16 contained so-called colloid. The contents of an occasional cyst or vesicle appeared pink when stained for mucus. This was not considered to be significant since the same tinctorial reaction was observed in sections of the thyroid gland. The colloid-containing cysts were lined with a single row of nonciliated flattened cuboidal cells. The cytoplasm was scanty and the nuclei were prominent and stained deeply (Fig. 4, *b*). The cysts were encountered at random anywhere from the center to the periphery of the gland. Occasionally, acini and small cysts were seen in nests of parathyroid cells in the fat surrounding the parathyroid gland. Without the aid of serial sections we were unable to determine whether these nests of cells represented projections from the parathyroid gland or isolated masses of cells. In all 16 cases the cysts were multiple and numerous transition stages, from the smallest colloid-containing vesicle to the largest cyst, could be seen (Fig. 5). The resemblance of the cysts to the colloid-containing vesicles found in 84 per cent of the cases was striking. In fact, the only difference in appearance, other than size, between vesicles and cysts was progressive flattening of lining cells, which apparently occurred as the cysts increased in size. It would seem reasonable to believe, therefore, that these cysts developed from small colloid-containing vesicles as a result of excessive accumulation and retention of colloid.

The cysts in 3 cases differed from those just described in that they were solitary and contained no colloid. Their epithelial lining cells, however, were identical to those seen in the colloid-containing cysts. Although the evidence was not as clear-cut as with the colloid cysts, it was felt that they too arose from colloid-containing vesicles. In the final case in the group, the cysts consisted of multiple irregular spaces lined with wasserhelle cells. None of the cystic spaces in this case were larger than 450 microns in diameter and it was not certain whether they should be classified as true cysts.

COMMENT

Many theories have been proposed to explain the cause of parathyroid cysts. Schaper,[16] Müller,[17] and Forsyth[18] independently proposed that parathyroid cysts were formed by retained secretions of parathyroid cells. Both Alagna[19] and Welch,[20] however, expressed the belief that colloid in a parathyroid gland was abnormal and concluded, therefore, that the cysts resulted from degeneration and not from secretion. Verdun,[21] Lusena,[22] Nylander,[5] and Anzilotti[3] have each suggested that parathyroid cysts arose from vestigial pharyngobranchial ducts or remnants of the third or fourth pharyngeal pouch. Gilmour[23] called attention to the existence in the fetus of certain vesicular, canalicular, or glandlike rudiments, previously described by Kürsteiner, that are derived from the parathyroid and the thymus or its associated thymic cord. In a subsequent communication he reported[10] that he had observed these rudimentary structures near the parathyroid glands in adults and stated that they were more commonly associated with the inferior glands. Similar structures were found in an occasional case of our necropsy series. We were unable to determine whether they represented embryologic remnants or cysts in the nests of parathyroid cells previously mentioned as sometimes found in the fat adjacent to the parathyroid glands. Gilmour,[10] von Verebélÿ,[14] Erdheim,[24] and Maresch[25] have reported cases of unilateral or bilateral aplasia of the thyroid gland in which cysts were found near the superior parathyroid glands. It has been suggested that the absence of the thyroid, into which the ultimobranchial body is said to enter, may favor the development of a cyst.

The diminutive size of parathyroid cysts and the fact that the parathyroid glands are not routinely visualized during the course of thyroidectomy probably explain why such cysts have been so rarely found by surgeons. Clinically, large parathyroid cysts are almost invariably thought to be nodular goiters. They lie in the loose areolar tissue behind the thyroid gland and are not attached to the surrounding structures. The cysts can be removed easily by blunt dissection but caution must be exerted to prevent injury to the recurrent laryngeal nerve which lies contiguous to the posterior wall of the cyst.

SUMMARY AND CONCLUSIONS

Gross cysts, the walls of which contain parathyroid tissue, are found rarely in the usual positions of the parathyroid glands. The fact that we encountered 2 such cases prompted a study of the parathyroid glands found in 100 routine necropsies. Vesicles were found in 84 per cent and cysts larger than 100 microns in diameter were present in 42 per cent of the cases. The finding of numerous

transitional stages from the smallest vesicles to large cysts led to the conclusion that these cysts resulted from retention. Presumably, the rare gross cysts result from the same process and the presence of compressed parathyroid tissue in the walls of the cysts would support this conception. Whether cysts of vestigial origin develop in the same region could not be answered.

REFERENCES

1. McKnight, R. B.: Parathyroid Cyst, South. Surgeon **12**: 179-184, 1946.
2. Goris: Exstirpation von drei cystischen Nebenschilddrüsenlappen. Exstirpation de trois lobules parathyroïdiens kystiques. (Abstr.) Internat. Centralbl. f. Laryngol., Rhinol. u. v. Wissensch. **22**: 190, 1906.
3. Anzilotti, G.: Contributo alla patogenesi delle cisti parabranchiali del collo; ciste del ductus parathyroideus, Clin. chir., Milano **17**: 610-618, 1909.
4. deQuervain: Epithel-Körperchen-Cyste, Schweiz. med. Wchnschr. **55**: 1169, 1925.
5. Nylander, P. E. A.: Ueber parathyreoideale Halszysten, Acta chir. Scandinav. **64**: 539-547, 1929.
6. Welti, H.: A propos des kystes parathyroïdiens, Mém. Acad. de chir. **72**: 33-35, 1946.
7. Welti, M. H.: Personal communication to the authors.
8. Cowdry, E. V.: A Textbook of Histology, Philadelphia, 1944, Lea & Febiger, pp. 117-118.
9. Marine, David, The Thyroid, Parathyroids and Thymus, in Cowdry, E. V.: Special Cytology, New York, 1932, Paul B. Hoeber, Inc., p. 828.
10. Gilmour, J. R.: The Normal Histology of the Parathyroid Glands, J. Path. & Bact. **48**: 187-222, 1939.
11. Thompson, R. L., and Harris, D. L.: A Consideration of the Pathological Histology of the Parathyroid Glandules, and a Report of a Parathyroid-like Tumor, J. Med. Research **19**: 135-152, 1908.
12. Petersen: Quoted by McKnight.[1]
13. von Verebélÿ, T.: Quoted by McKnight.[1]
14. von Verebélÿ, T.: Quoted by Gilmour.[10]
15. Castleman, B., and Mallory, T. B.: Pathology of Parathyroid Gland in Hyperparathyroidism; Study of 25 Cases, Am. J. Path. **11**: 1-72, 1935.
16. Schaper: Quoted by Alagna.[19]
17. Müller: Quoted by Alagna.[19]
18. Forsyth, David: The Parathyroid Glands. II. Their Pathology in Man, Quart. J. Med. **1**: 287-311, 1908.
19. Alagna, Gaspare: Cisti paratiroidee, Anat. Anz. **33**: 406-417, 1908.
20. Welch, D. A.: On the Parathyroid Glands of the Cat: A Preliminary Study in Experimental Pathology, J. Path. & Bact. **5**: 202-220, 1898.
21. Verdun: Quoted by Alagna.[19]
22. Lusena, Gustavo: Cisti ad epitelio cigliato in glandole paratiroidee esterne, Anat. Anz. **15**: 52-56, 1898.
23. Gilmour, J. R.: The Embryology of the Parathyroid Glands, the Thymus and Certain Associated Rudiments, J. Path. & Bact. **45**: 507-523, 1937.
24. Erdheim, J.: Quoted by Gilmour.[10]
25. Maresch, R.: Quoted by Gilmour.[10]

Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

LUMBAR SYMPATHECTOMY FOR ARTERIOSCLEROSIS OBLITERANS

RATIONALE AND RESULTS

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THE impression that vasospasm is not considered to be a factor present in most cases of obliterative arteriosclerosis has led most physicians and surgeons to believe that interruption of the sympathetic innervation to ischemic areas in this disease is not a rational procedure.

It is the purpose of this communication to draw attention to the ultilization of lumbar sympathectomy in patients with arteriosclerotic peripheral vascular disease and the results achieved which are incompatible with the prevailing belief in this regard, and to point out why we believe that a change in attitude concerning operative intervention is desirable.

The term "arteriosclerosis obliterans" is misleading if one presupposes that this implies inability of the smaller blood vessels to dilate. We, as well as others, have repeatedly noted a marked increase in the skin temperature in arteriosclerotic legs following lumbar sympathectomy. This is true whether or not vasospasm, as judged by the presence of coldness and moisture of the extremity, is present or absent preoperatively. Despite marked organic involvement of the major vessels, the collateral and smaller vessels may be singularly uninvolved in many instances. This has been demonstrated time and again by microscopic examination of the tissues in legs amputated for arteriosclerotic gangrene (Figs. 1, 2, 3, and 4), and also in routine autopsy studies.

Actually, the major vessels are softer rather than harder than normal, except in areas where atheromatous plaques have become calcified. In our thinking about arteriosclerosis, we must remember that the name of this disease is not so much a perfect descriptive term as it is a historical one which conveniently covers several types of intimal and medial arterial wall disease.

Permanent interruption of sympathetic impulses does not, in so far as we know, affect the major vessels, but rather favors the development of a more useful and more extensive collateral circulation. Arteriosclerosis obliterans must be considered a true organic disease and not merely a process which is the inevitable result of aging. Most of the fatalistic attitude prevalent heretofore with regard to discovering the etiology and cure of arteriosclerosis stems

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from the old belief that this condition is merely a "wear and tear" phenomenon. The premature appearance of marked arteriosclerosis in some young human beings, and its experimental production in animals on high cholesterol diets militates against the feeling that this is not a true disease. Only recently Moschovitz,[1] in a monograph on arteriosclerosis, wrote that "unless the individual is cut down by intercurrent disease, death is invariably the result of arteriosclerosis. It is the inevitable destiny of all creatures who possess a cardiovascular system with intravascular pressure. . . . Arteriosclerosis being an inevitable consequence of aging and therefore an irreversible process, it is

Fig. 1.—Photomicrograph showing thrombosed arteriosclerotic artery from limb amputated for arteriosclerotic gangrene in a diabetic patient. Other vessels at this level (calf) were completely occluded by arteriosclerotic plaques. (×20.)

hardly likely that any method of therapy will ever be discovered which will restore the diseased vessels to their normal texture, unless we can cure mortality, nor can arteriosclerosis be prevented, no more than gray hair or facial wrinkles."

The American Society for the Study of Arteriosclerosis was founded because there existed students of this disease who did not agree with Moschovitz and others holding the views expressed here. Certainly such lifelong students

of pathology as Mac Callum[2] and Rich[3] do not subscribe to such a fatalistic view. This matter is mentioned only because it is obvious that the consideration of lumbar sympathectomy or any other form of treatment cannot be seriously considered unless arteriosclerosis is considered to be a true disease with an etiology, although unknown, and presumably, therefore, methods of prevention and treatment.

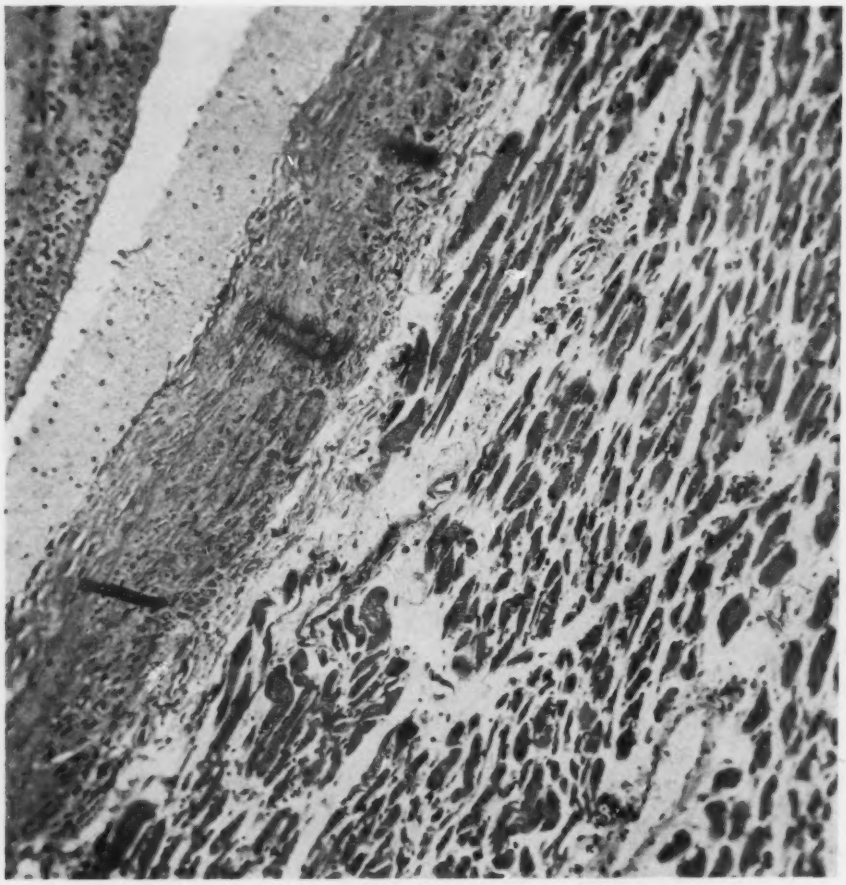


Fig. 2.—Higher magnification showing section of wall of artery shown in Fig. 1. Note normal arterioles in tissue near by. (×150.)

Inasmuch as sympathectomy was believed to be indicated only in vasospastic states, no thought was given to this procedure as a possible therapeutic aid in peripheral arteriosclerotic vascular disease until Harris[4] and Leriche and Fontaine[5] in 1935 and 1936, respectively, published results in a few cases in which surprising benefit from sympathectomy was observed. At that time de Takats[6] (who now advocates the operation in properly selected cases) felt sympathectomy in arteriosclerosis was "an unnecessary type of surgery which discredited the excellent results obtained in Raynaud's disease, Buerger's disease and many other vasospastic phenomena." In 1941, Atlas[7] and Freeman and Montgomery[8] made contributions of the greatest significance when they

demonstrated that patients with intermittent claudication and other symptoms due to arteriosclerosis obliterans were afforded temporary relief by sympathetic procaine blocks, and that patients so selected responded more permanently to lumbar sympathectomy. Patients with intermittent claudication walked further without cramps while under the influence of lumbar sympathetic block, so it was reasonable to perform lumbar sympathectomy for more lasting relief. At the same time Ives[9] reported good results with lumbar procaine block and sympathectomy in arteriosclerosis obliterans. Pearl[10] had previously shown that paravertebral block abolished angiospastic phenomena while walking in some patients with arteriosclerosis.

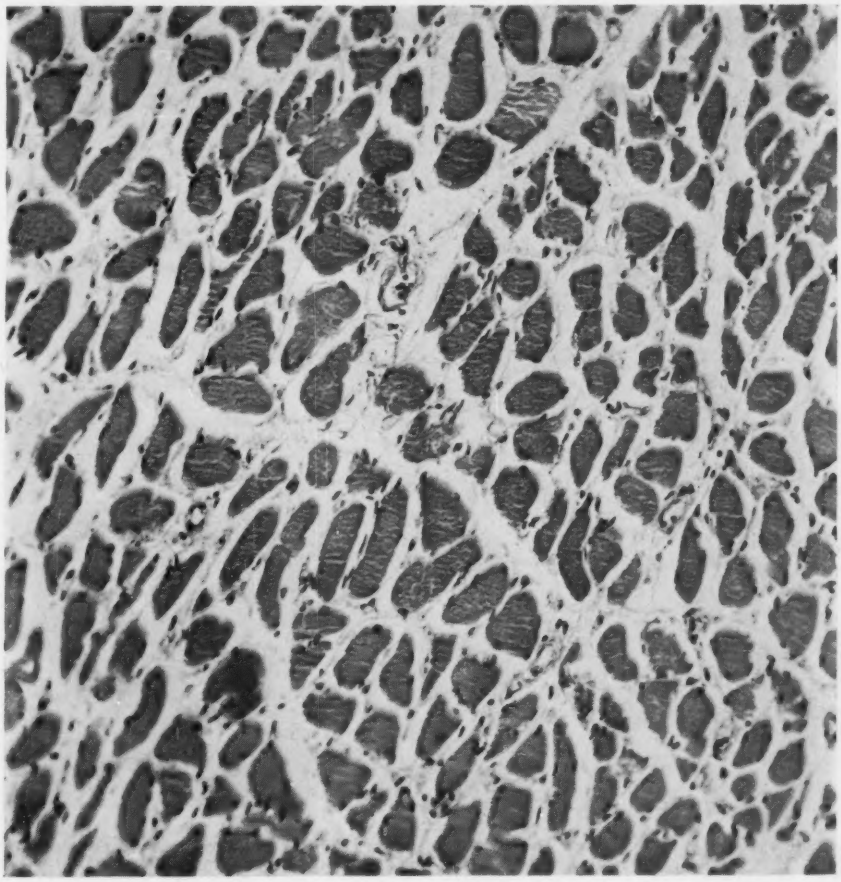


Fig. 3.—Section through calf muscles at same level. Note normal appearing collateral small vessels within the muscles. (×200.)

Trimble, Cheney, and Moses[11] in 1944 and de Takats, Fowler, Jordan, and Risely[6] in 1946 published series of cases of arteriosclerosis in which lumbar sympathectomy proved of great value.

More recently, large series of arteriosclerotic patients with obliterative disease involving the legs have been reported by Yeager and Cowley,[12] Shumacher,[13] and Coller, Campbell, Harris and Berry.[14] In these studies the value of lumbar sympathectomy would appear to be confirmed beyond doubt.

The evidence in favor of the value of this operation in arteriosclerosis obliterans as reported by various surgeons is as follows:

Harris (1935).—Twelve patients were operated upon at the Toronto General Hospital in the preceding four years with good sustained improvement in five cases.[4] In these five patients, postoperative skin temperature elevations ranged from 3° to 10° C. (average 6.2° C.). One patient had a good immediate response to sympathectomy but then suffered a relapse of symptoms and amputation became necessary. In the group of six patients having a poor response

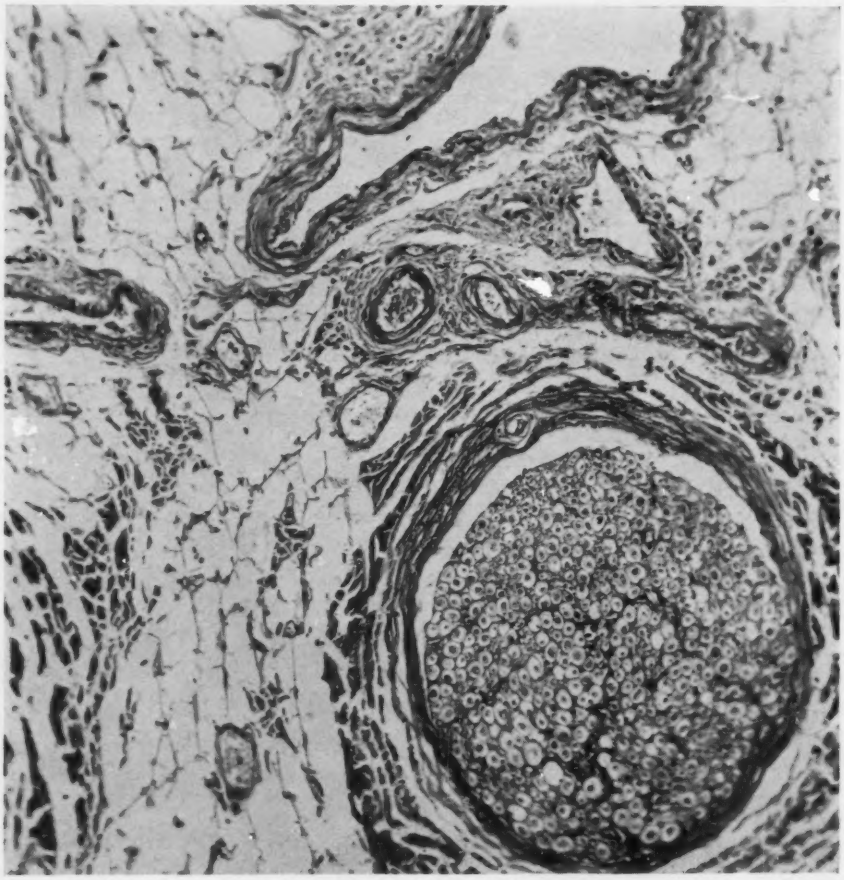


Fig. 4.—A bundle of fibers of the peroneal nerve. Note many normal-appearing arterioles in vicinity. The larger vessels at top of field are arteriosclerotic but the smaller vessels are uninvolved. (×125.)

to sympathectomy, the extremes in postoperative skin temperature elevations were 0 and 3° C. Harris emphasized the value of preoperative tests using spinal anesthesia or posterior tibial nerve block to alter skin temperature in involved extremities in the selection of cases for operation. He found that in responsive patients rest pain was alleviated and unhealed wounds were healed. Small patches of gangrene were cured.

Leriche and Fontaine (1936).—Eight patients were subjected to lumbar sympathectomy for arteriosclerosis obliterans at Leriche's Clinic in Strasbourg.[5] Many more underwent periarterial stripping (periarterial sympathectomy) with

equally good results in the opinion of these investigators. Leriche recently discussed the results of sympathectomy for various diseases in over 800 patients.[15] He classifies arteriosclerosis obliterans and thromboangiitis obliterans together as "arteritis." There were 501 cases of Buerger's thromboangiitis, "arteritis" due to deposits in the arterial wall (arteriosclerosis), and the "mixed forms observed in patients around 40." Bilateral ganglionectomy often accompanied by arteriectomy has been the procedure used in these latter forms of obliterative arterial disease. While this report is of a very general nature based on rather homogeneous statistics, it is apparent that Leriche has obtained many gratifying results in sympathectomy for arteriosclerosis obliterans. He believes that better results are to be expected in early symptomatic cases than in far-advanced cases. In discussing the results of operation in the 501 cases of arteritis as a whole, he stated that, "I count roughly 20 per cent of total failures, that is to say of cases in which the patient's condition grew worse and where it was finally necessary to amputate, either because of gangrene, or on account of residual pain; 30 per cent of fair results, with persistence of some symptoms, ulceration or pain; 50 per cent of good, generally permanent results."

Atlas (1942).—Twelve patients with peripheral arteriosclerotic vascular disease who were followed for over one year after sympathectomy at Cleveland City Hospital were reported.[7] Eight other patients followed for less than one year postoperatively were not included in the report because of the brevity of their follow-up period. Intermittent claudication, which was present in nine patients before operation, disappeared after operation in seven. The relief of other symptoms resulting from vascular occlusion and the general improvement in the extremities after operation led Atlas to become an enthusiastic supporter of this procedure in selected cases, that is, those with collateral vascular beds capable of hypertrophy. Subsequently, he reported[16] three instances of gangrene resulting from sympathectomy in arteriosclerosis in spite of skin temperature elevation. The true cause of this paradoxical result remains obscure.

Freeman and Montgomery (1942).—In twelve patients studied at the University of Pennsylvania because of intermittent claudication, all were subjected to temporary Novocain sympathetic blocks. Of the six patients subsequently undergoing lumbar sympathectomy, one, at least, had arteriosclerosis (with vasoconstriction). This patient could walk only one block prior to sympathetic injection, two and one-half blocks after sympathetic injection, and fifteen blocks after lumbar sympathectomy.[8] Recently (1947), Freeman, with Leeds and Gardner,[17] published a report decrying indiscriminate sympathectomy in advanced obliterative vascular disease without good evidence of associated vasospasm. Cases of so-called paradoxical gangrene following sympathectomy were cited to illustrate the possible mechanism of actual short circuiting of arterial supply through the opening of capillary arteriovenous shunts. Freeman emphasized in his discussion that such a mechanism is purely hypothetic. Some of the other discussants of the paper doubted that paradoxical gangrene is a true entity and that in the rare case where the gangrenous process accelerates after operation, thrombosis of a major vessel is the cause.

Ives (1943).—Good results from lumbar procaine block and sympathectomy in arteriosclerosis obliterans were reported.[9] In six of seven patients undergoing sympathectomy for arteriosclerosis obliterans with severe intermittent claudication but without gangrene, good results were achieved. All patients whose ages averaged 60 had shown a good preoperative leg temperature rise after lumbar procaine block. In each the popliteal, posterior tibial, and dorsalis pedis pulses were absent. Ives ascribed his good results to the probability that the vasospastic element in arteriosclerosis was of more importance than had been previously thought.

Trimble, Cheney, and Moses (1944).—Twenty-four patients undergoing lumbar sympathectomy for arteriosclerosis at the Baltimore City Hospital were reported. These authors' pointed out that in obliterative vascular disease, the differential diagnosis is not always possible, so that in additional patients the diagnosis of Buerger's disease rather than arteriosclerosis was sometimes quite arbitrary. It was found in this study that indolent ulcers associated with arteriosclerosis may heal rapidly following sympathectomy; sympathectomy may save the remaining leg after the other leg has been amputated for gangrene; sympathectomy serves as a good prophylactic measure where ulceration seems imminent; the operation relieves associated pain in arteriosclerotic ulcers, toes and feet, and claudication in many cases.[11] They found that negative preoperative tests to rule in or out an associated vasospastic condition does not preclude good end results from sympathectomy. They stressed the importance of the association of vasospasm with organic arteriosclerotic occlusion and concluded that gangrene or the threat of spread of established gangrene is amenable to sympathectomy. They believed, and we feel rightly so, that the current fallacy of not sympathectomizing patients with advanced arteriosclerosis was disproved by their study.

de Takats, Fowler, Jordan and Risely (1946).—Lumbar sympathectomy was carried out in twenty-five patients suffering from vascular sclerosis of the lower extremities when, after preliminary lumbar sympathetic block, the temperature of the digits increased, if walking ability improved, and if generalized vascular involvement was not extensive.[6] In one group of patients there was a dramatic increase in walking ability and in another group amputation was averted. In a third group amputations could be performed at lower levels and in a fourth group, intractable neuritic pain of the causalgic type was benefited. These authors concluded from this study, done at the University of Illinois, that in selected cases of peripheral arteriosclerosis, lumbar sympathectomy has proved to be of great value.

Yeager and Cowley (1948).—These authors reported that while sympathectomies in degenerative organic vascular disease had been performed since 1939 at the University of Maryland Hospital, Baltimore, the operation is now limited to those patients with demonstrable associated vasospasm, not responding to conservative measures, including such procedures as paravertebral blocks.[12] One hundred fifty patients were subjected to lumbar sympathectomy for degenerative organic vascular disease. These authors did not state in how many the diagnosis of arteriosclerosis was made.

Shumacker (1948).—In a series of 627 patients undergoing sympathectomy for peripheral vascular disease at the Johns Hopkins Hospital, the New Haven Hospital, and at various Army Hospitals, there were 134 operations (number of patients not stated) for arteriosclerosis. In general, Shumacker[13] believes the results of this operation are excellent.

Opinions of Ochsner, Reichert, Trimble, Maddock, Matas, and Herrmann (1947).—In the discussion of Freeman's paper previously mentioned,[17] Ochsner[18] stated, "We have become increasingly more impressed by the desirability of resorting to sympathectomy even in older persons who have obliterative arterial disease and, although in not all of these patients can the extremity be salvaged, the salvage incidence is about 75 per cent, which makes the procedure justifiable." We have also learned that the results obtained by temporary blocking of the sympathetic nerves by Novocain will not give a true indication of what can be obtained by sympathectomy in these older individuals. Reichert[19] is in substantial agreement with these opinions, as are Trimble[20] and Maddock.[21] Matas[22] and Herrmann[23] agree with Freeman that great caution is necessary in case selection.

Coller, Campbell, Harris, and Berry (1948).—These authors performed lumbar sympathectomy for far-advanced arteriosclerosis obliterans at the University of Michigan Hospital. Eighty-three patients with ulceration and/or gangrene (grades 3 and 4 of de Takats) underwent operation with a limb salvage rate of over 70 per cent.[14] No particular attention was paid to selection of cases with vasospasm as determined by preoperative sympathetic blocks using tetraethylammonium bromide.[24]

Alexander Blain Hospital Series (1948).—In a small group of patients with arteriosclerosis obliterans (the majority without frank gangrene or ulceration) lumbar sympathectomy has been performed since July, 1947. There were eight operations on six patients. One death in this group represents the only mortality in twenty-five operations performed on thoracic and lumbar sympathetic nervous systems during this period by one of us (A. B.). The patient, with severe diabetes and a badly damaged heart, had arteriosclerotic gangrene. In spite of the most careful preoperative preparation, the patient, died three days postoperatively in auricular fibrillation. In another patient with gangrene, sympathectomy was of no avail and amputation was later necessary. The remaining patients had intermittent claudication, coldness and dampness of the extremities, rest pain (one case), ischemic neuritis of the causalgic type (two cases), and absent peripheral pulses. These symptoms were considerably ameliorated by operation. Walking distance without claudication increased and neuritic pain, coldness, and excessive dampness disappeared. In one patient the dorsalis pedis pulses which were not palpable preoperatively became palpable after sympathectomy. Further time, of course, is necessary for evaluation of end results in these cases.

EFFECT OF SYMPATHECTOMY ON VARIOUS MANIFESTATIONS OF ARTERIOSCLEROSIS OBLITERANS

Vasospasm.—In those cases where the presence of associated vasospasm can be demonstrated by either coldness and dampness of the extremity or preopera-

tive sympathetic block, sympathectomy is indicated because this associated factor plus organic vascular occlusion may be sufficient to produce decompensation of local circulation. Where vasospasm is apparently not associated with arteriosclerotic involvement of major vessels, sympathectomy is still indicated for its relaxation of tonus of the capillary bed and subsequent hypertrophy of anastomotic vessels, and alleviation of signs and symptoms of vasospasm.

Pain.—

Intermittent claudication and rest cramps: Pain due to ischemia of the calf muscles is definitely relieved in a majority of cases according to all authors reporting on this subject, and according to our own experience it is rarely completely cured. Whether or not sympathetic denervation of the muscle capillaries causes vasodilatation is controversial. It has been shown in sympathetic nerve stimulation experiments that these capillaries undergo dilatation. From the standpoint of the clinician, however, the marked relief of claudication and rest pain in patients following sympathectomy in adequate series should answer the question from the practical standpoint.

Pain due to ulceration: Pain due to ulceration is relieved before ulcer healing is complete in many instances. In such instances it would appear that pain is mediated over sympathetic fibers. As the operation usually results in healing of arteriosclerotic ulcerations, pain due to these ulcers is frequently abolished.

Pain due to ischemic neuritis: This pain which may be of a causalgic nature is often relieved by sympathectomy. De Takats drew attention to this in 1946. The mechanism of relief lies in both the interruption of pain-carrying sympathetic fibers and alleviation of the ischemia which produces the neuritis.

Ulcers.—As has been mentioned, ulcers are often cured if there is a capillary bed capable of hypertrophy. The increased blood supply and nutrition to the area involved are responsible for the healing.

Gangrene.—Far-advanced gangrene is an irreversible process but sympathectomy in the experience of most observers limits the spread of the gangrenous process or often averts threatened gangrene. Small areas of superficial gangrene may actually disappear after the local blood supply is improved by sympathectomy. Sympathectomy of the opposite leg following amputation for gangrene is believed to prevent or delay subsequent gangrene in that leg.

SELECTION OF CASES OF ARTERIOSCLEROSIS OBLITERANS FOR LUMBAR SYMPATHECTOMY

Hines and Barker,[25] in studying 240 patients with peripheral arteriosclerosis associated with peripheral vascular symptoms, found that 54.6 per cent died within three years of their first visit to the Mayo Clinic. The majority died of thrombosis of the coronary artery. In 56 per cent of the patients, ulceration or gangrene had been induced by incidental trauma or injudicious therapeutic measures and, of these, 62 per cent had to have an amputation. Campbell and Harris[26] found in studying a series of 350 patients with arteriosclerotic peripheral vascular disease at the University of Michigan, that some 220 were ultimately classified as being grade 3 or 4 of de Takats' classification (ulceration or gangrene present). None of these patients underwent lumbar

sympathectomy. One hundred fifty-seven of these patients underwent 116 supracondylar amputations. Seventy per cent of the group as a whole had some form of amputation and supracondylar amputation represented 69 per cent of the amputations performed. During the same time interval, supracondylar amputation was ultimately necessary in nine patients of a series of sixty-three previously subjected to lumbar sympathectomy. Approximately 70 per cent of the group having had lumbar sympathectomy evidenced arrest of their gangrene. The group undergoing sympathectomy were selected patients and while the two series cannot be directly compared because of extraneous factors, it would appear that the prognosis in the nonoperated series for salvation of the extremities was extremely poor as compared to the operated group. Other investigators have also reported significant salvage rates.

This poor prognosis for limb salvage in patients with symptomatic arteriosclerotic peripheral vascular disease must be the first consideration in attempting to define rules for selection of patients for sympathectomy. This is particularly so when ulceration or gangrene is present.

The data mentioned l[illegible]re would support the contention that sympathectomy should be done preferably prior to the onset of established ulceration or gangrene. With the increasing number of aged persons in this country, it would appear that a large number of people may become candidates for sympathectomy if this contention is correct.

Not all patients with arteriosclerotic vascular disease will prove to be candidates for sympathectomy. The following conditions have been suggested by various writers as contraindications:

(1) Severe cerebral and/or renal involvement

(2) Cardiac decompensation which cannot be adequately controlled

(3) A paradoxical response to sympathetic block, that is, the symptomatology is aggravated or the extremity deleteriously affected

(4) Rapidly progressive deterioration of vascular supply by thrombosis, etc.

The group usually selected for lumbar sympathectomy has demonstrated:

(1) Some response to sympathetic block which may consist of subjective symptomatic relief or an objective rise in peripheral temperature and blood flow

(2) Evidence of arrest or improvement of the process during a period of conservative therapy which included cessation of smoking, control of diabetes when present, periodic sympathetic blocks, vascular exercises, and chemotherapy when indicated

(3) All methods of conservative therapy proved of no avail in a number of patients and lumbar sympathectomy was undertaken as a last resort

In our experience only three factors have proved constantly significant in influencing us against the selection of patients for sympathectomy irrespective of systemic involvement. These factors are:

(1) Marked atrophy of the extremity with loss of subcutaneous tissue and consequent diminution in available vascular bed

(2) The rapid onset of symptoms and a rapidly progressive vascular lesion

(3) Constant intractable pain uninfluenced by sympathetic block

The combination of these three factors was found to be present in 100 per cent of the cases having a poor result from lumbar sympathectomy at the University of Michigan.

In summary, while most students of this problem will agree on the contraindications enumerated here, and while increasing experience seems to indicate that appreciable benefit may be expected in selected far-advanced cases with an exceedingly low operative mortality, there is considerable difference of opinion as to the selection of early cases of symptomatic arteriosclerosis obliterans (no skin breakdown) for sympathectomy.

We have adopted the point of view that in the latter type of case, sympathectomy is of prophylactic as well as therapeutic value and that the individuals so chosen for this procedure should be individually and carefully selected depending upon their response to conservative management, environmental factors, economic factors, and so on. The accuracy of this selection will be enhanced by increasing experience and study.

It should also be remembered that many of the gangrenous or ulcerating lesions in these patients reach a state of arrest irrespective of sympathectomy, and that the additional usual conservative measures employed in vascular disease directly influence the end result if sympathectomy is performed. The patient with arteriosclerosis obliterans is only too frequently subjected to a wheel chair existence. In addition, he represents an economic burden of considerable magnitude to his family and community. Lastly, he is able rarely to utilize an artificial prosthesis satisfactorily.

DISCUSSION

There is much in the literature of a rather controversial or theoretical nature regarding the mechanism of autonomic control of the peripheral vascular system. Furthermore, there is much that is not known concerning the pathology of arteriosclerosis and other obliterative vascular disorders. It is not our purpose in this report to discuss any aspects of the problem other than those which seem at present to be well substantiated.

The clinical results of sympathectomy for arteriosclerosis in the studies mentioned are sufficiently encouraging to warrant continued investigation of this procedure. New studies of peripheral circulation such as those utilizing radioactive tracer substances may in the future render much of our present knowledge obsolete.

While selection of cases for operation on a clinical basis would seem to be of major importance, the encouraging experience of the Ann Arbor group in unselected far-advanced cases shows how little is known concerning selection. Only ischemic results in the lower extremities at present seem amenable to sympathetic interruption although, as is well known, anginal pain due to

coronary artery arteriosclerosis may be ameliorated by dorsal sympathectomy, and cervical and stellate ganglion block is of value in apoplexy due to cerebral thrombosis in arteriosclerosis of the cerebral arteries.[27] We have encountered only one case of gangrene of the upper extremity associated with arteriosclerosis. This patient, who had generalized xanthomatosis of the hypercholesterolemic type, had progeria and arteriosclerosis.[28] It was not known whether bilateral gangrene of the fingers necessitating amputations was due to arteriosclerosis, xanthomatous involvement of the blood vessels, or both. The presence of scleroderma and tissue atrophy discouraged dorsal sympathectomy.

SUMMARY

Contrary to popular opinion, sympathectomy appears to be a very effective procedure in the treatment of selected cases of arteriosclerosis obliterans of the lower extremities. Present criteria for selection are not rigidly established. The rationale and results of this operation have been discussed. It should be remembered that sympathectomy is intended to dilate the capillary bed and not the major arteriosclerotic vessels. Arteriolosclerosis as seen, for example, in the kidney is not so frequently encountered in the extremities. In the relief of pain and claudication, those pain impulses carried by sympathetic fibers are blocked. Walking distance is often dramatically improved and gangrene is often prevented or limited. Ulcers are often healed. Further studies are necessary to solve many of the questions which remain unanswered as to indications, mechanism of action, and results. For the present, it may be concluded that lumbar sympathectomy offers the best hope to individuals suffering from symptomatic peripheral arteriosclerosis obliterans of the lower extremities. Increasing collateral blood supply through capillary dilatation is indicated in the presence of gangrene, ulcers, intractable pain, and intermittent claudication not responding to conservative measures. If gangrene is threatened as judged by clinical examination, or if the contralateral extremity has been amputated for gangrene, sympathectomy should be done prophylactically. In the latter case, it should be remembered that the remaining leg must do the work of two legs and this greater demand may hasten vascular decompensation. The status of so-called paradoxical gangrene following sympathectomy is not clear. This phenomenon is supposed to result from the opening of capillary arteriovenous shunts which short-circuit the arterial blood supply to the toes. In our experience at the University of Michigan such an occurrence was seen in three of over eighty cases and then was limited only to small areas of gangrene in the toes. The Adrenergic Sensitization Phenomenon which constitutes a real problem in sympathetic denervation of the upper extremities appears to be no problem in lumbar sympathectomy. While Leriche believes that bilateral removal of the first lumbar sympathetic ganglion does not interfere with sexual function, we, along with most other Americans, have been accustomed to removing only the second, third, and fourth ganglia with the intervening sympathetic trunk and corresponding rami communicantes. Retroperitoneal exposure of the chain through a transverse incision at the umbilical level is the technique favored at our Clinic.

REFERENCES

1. Moschovitz, E.: Vascular Sclerosis, New York, 1942, Oxford University Press.
2. Mac Callum, W. G.: A Textbook of Pathology, ed. 7, Philadelphia, 1941, W. B. Saunders Company.
3. Rich, A. R.: Personal Communication.
4. Harris, R. I.: The Role of Sympathectomy in the Treatment of Peripheral Vascular Disease, Brit. J. Surg. **23**: 414-420, 1935.
5. Leriche, R., and Fontaine, R.: Einige Bemerkungen über 1199 Operationen am Sympathikus, Arch. f. klin. Chir. **186**: 338-350, 1936.
6. De Takats, G., Fowler, E. F., Jordan, P., and Risely, T. C.: Sympathectomy in the Treatment of Peripheral Vascular Sclerosis, J. A. M. A. **131**: 495-499, 1946.
7. Atlas, L. N.: Lumbar Sympathectomy in the Treatment of Selected Cases of Peripheral Arteriosclerotic Disease, Am. Heart J. **22**: 75-85, 1941.
8. Freeman, N. E., and Montgomery, M.: Lumbar Sympathectomy in the Treatment of Intermittent Claudication: Selection of Cases by Claudication Test With Lumbar Paravertebral Procaine Injection, Am. Heart J. **23**: 224-242, 1942.
9. Ives, H. R.: Lumbar Procaine Block and Sympathectomy in Arteriosclerotic Endarteritis, Proc. Roy. Soc. Med. **36**: 339-340, 1943.
10. Pearl, F.: Angiospastic Claudication, With a Report of Six Cases, Am. J. M. Sc. **194**: 505, 1937.
11. Trimble, I. R., Cheney, W. S., and Moses, W. R.: The Operative Attack on Organic Vascular Disease, SURGERY **13**: 655-678, 1944.
12. Yeager, G. H., and Cowley, R. A.: Anatomical Observations on the Lumbar Sympathetics With Evaluation of Sympathectomies in Organic Peripheral Vascular Disease, Ann. Surg. **127**: 953-967, 1948.
13. Shumacker, H. B., Jr.: Sympathetic Denervation of the Extremities; Operative Technique, Morbidity and Mortality, SURGERY **24**: 304-325, 1948.
14. Coller, F. A., Campbell, K. N., Harris, B., and Berry, R. L.: The Early Results of Sympathectomy in Far Advanced Arteriosclerotic Peripheral Vascular Disease, SURGERY (In Press).
15. Leriche, R.: Communications Concerning 800 Lumbar Ganglionectomies. Medical Research in France During the War 1939-1945, Editions Medicales, Paris, 1948, Ernest Flammarion, pp. 275-283.
16. Atlas, L. N.: Lumbar Sympathectomy in the Treatment of Selected Cases of Peripheral Arteriosclerotic Disease, 2. Gangrene Following Operation in Improperly Selected Cases, Am. Heart J. **23**: 493-497, 1942.
17. Freeman, N. E., Leeds, F. H., and Gardner, R. E.: Sympathectomy for Obliterative Arterial Disease; Indications and Contra-indications, Ann. Surg. **126**: 873-894, 1947.
18. Ochsner, A.: In discussion of Freeman, Leeds, and Gardner.[17]
19. Reichert, F. L.: In discussion of Freeman, Leeds, and Gardner.[17]
20. Trimble, I. R.: In discussion of Freeman, Leeds, and Gardner.[17]
21. Maddock, W. G.: In discussion of Freeman, Leeds, and Gardner.[17]
22. Matas, R.: In discussion of Freeman, Leeds, and Gardner.[17]
23. Herrmann, L. G.: In discussion of Freeman, Leeds, and Gardner.[17]
24. Campbell, K. N., Lyons, R. H., Moe, G. K., Berry, R. L., and Surtler, M. R.: Tetraethylammonium Bromide in Peripheral Vascular Disease and Allied Disorders. A New Method of Blocking the Autonomic Ganglia, Alexander Blain Hosp. Bull. **5**: 108-114, 1946.
25. Hines, E. A., Jr., and Barker, N. W.: Arteriosclerosis, Am. J. M. Sc. **200**: 717-730, 1940.
26. Campbell, K. N., and Harris, B.: Unpublished data.
27. Blain, A., III.: Cervical Sympathetic and Stellate Ganglion Block in Apoplexy: Preliminary Note on Indications and Technique, J. Michigan M. Soc. **47**: 1356-1358, 1948.
28. Blain, A., III., Campbell, K. N., and Iob, V.: Generalized Xanthomatosis With Peripheral Gangrene, Alexander Blain Hosp. Bull. **6**: 158, 1947.

Book Reviews

Intracranial Tumors. By Percival Bailey, M.D., Professor of Neurology and Neurological Surgery, University of Illinois. Pp. 478, with many illustrations. Springfield, Ill., 1948, Charles C Thomas, Publisher.

There is no one better qualified to present the problems of intracranial neoplasms than Dr. Bailey. The first edition of his book was very well received. The second edition has been enlarged upon by the inclusion of chapters on the allied sciences and numerous case histories. Although the scope of the book has thereby been increased, much of its exacting clarity has been lost.

The first part of the book is lent to a discussion of tumors in general, neuroanatomy, and neurophysiology. It affords a concise and detailed understanding of the theories of tumor growth. The role of cerebrospinal fluid and of the vascular supply of the brain in symptom production is delineated.

The second part of the book contains a discussion of intracranial tumors from a clinicopathologic standpoint. One or more chapters are devoted to each of the more common tumor types. Numerous case reports illustrative of the various types of brain tumors are given and there is also a discussion of the problems incident to both the clinical and histological diagnosis. The microscopic and gross material is illustrated by hand drawings rather than photographs. I feel the drawings inadequately interpret the actual appearance of the tissues.

The third part of the book includes a discussion of the general and differential diagnosis and of the treatment of brain tumors. The discussion of symptomatology is not particularly up to date but that of differential diagnosis is excellent. The discussion of surgical treatment is limited to a few general principles.

An atlas of roentgenograms is given, illustrating the principal abnormalities encountered in patients with brain tumors and reviewing the various roentgenographic procedures used in neurologic diagnosis.

This book is valuable because it is a composite of Dr. Bailey's understanding of brain tumors. As such, it should be studied by all students of neuropathology, neurology, and neurosurgery.

Cancer of the Esophagus and Gastric Cardia. Edited by George T. Pack, M.D. Pp. 192, with 97 illustrations. St. Louis, 1948, The C. V. Mosby Company. $3.

This monograph is a valuable addition to the library of any physician or surgeon interested in lesions of the upper part of the stomach and esophagus. It is comprehensive, authoritative, and well illustrated. The surgical techniques are described in detail.

Textbook of Genito-Urinary Surgery. Edited by H. P. Winsbury-White, M.D., Ch.B., F.R.C.S., Surgeon, St. Paul's Hospital for Genito-Surgery Diseases, London, England. Pp. 1,046, with illustrations. Baltimore, 1948, Williams & Wilkins Company.

This is really a British system of urology and constitutes quite an exhaustive treatise. In general it covers the subject quite thoroughly, although the reviewer was disappointed to find relatively few references to literature. So large a work would be more useful if it could be used as a book of reference as well as a text.

It is for the most part well illustrated, but the various discourses on embryology are hard to follow because of a total lack of illustrations. As has come to be expected in American texts of urology also, it perpetuates certain ill-founded myths: that saline intravenously is indicated in anuria; that sulfathiazole will kill the *Bacillus proteus* (sulfathiazol will not); that sudden emptying of the distended bladder is dangerous; and that Novocain is effective as a topical anesthetic.

There is a definite tendency to be too dogmatic about many things, that is, "any amount of residual urine over two ounces causes renal damage."

The American urologist will be struck by certain differences between British and American urological thought: the discussion of anuria is much too short and seems to the reviewer out of date; the important role of transurethral resection in "cord bladder" is not mentioned; the mortality of suprapubic prostatectomy is given as 9 per cent, and the average postoperative stay in the hospital as twenty-eight days! No wonder that retropubic prostatectomy has its enthusiastic advocates.

Many in this country would dispute the statements that the suprapubic route is best for prostatic calculi and for operable prostatic cancer. The discussion of prostatic cancer assumes that the reader knows all about Huggins' work, and is therefore fragmentary indeed. The use of streptomycin in tuberculosis is not discussed (this is probably due to unforeseen delays in publication), and cystoscopic manipulation of ureteral calculi is almost ignored.

The various prostatic operations are discussed thoroughly, and one would have difficulty in thinking of any urological topic not at least mentioned in the text. Syphilis and bilharziasis (schistosomiasis) are discussed in some detail.

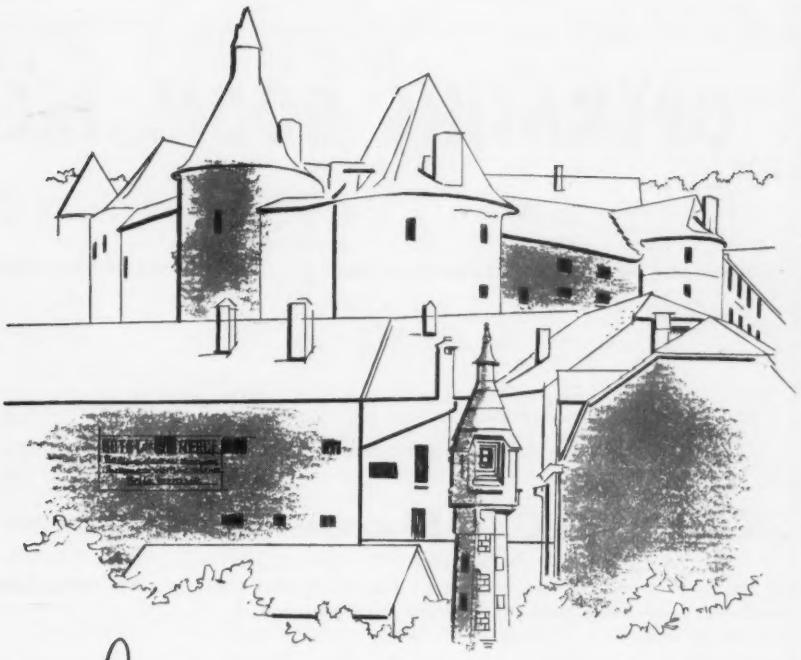
The reviewer has read this work with profit and pleasure notwithstanding the detailed criticism, although it was literally a heavy task which would have been lightened agreeably had the publisher seen fit to bind it in two volumes instead of one.

Diseases Affecting the Vulva. By Elizabeth Hunt, M.D. Ed. 3. Pp. 211, with 36 illustrations, plus 19 color plates. St. Louis, 1948, The C. V. Mosby Company.

Vulvar lesions often represent a distressing problem, both to the patient and to the practitioner. They are poorly understood and usually inadequately treated by the general medical profession. In the third edition of her volume on vulvar lesions, Hunt catalogues the current knowledge of all such lesions; this includes the etiology, clinical manifestations, and treatment of each. In addition to time-honored remedies, the use of penicillin, sulfonamides, and vitamins is discussed. The material is richly illustrated with color plates.

The gynecologist might take exception to minor points in the text. For example, opinion is growing that any form of vulvar malignancy should be radically excised, rather than treated with radon seeds, radium, or roentgen-ray, as advocated by Hunt. One cannot fail to note, also, that the treatment of many vulvar lesions advocated in this volume remains palliative rather than specific.

The revised edition will prove definitely valuable to all physicians who treat women. It will be of especial assistance to the general practitioner and internist whose acquaintance with vulvar pathologic conditions may be fragmentary.



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